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SCIENCE AND TECHNOLOGY ORGANISATION CANBERRA
(AUSTRALIA) 1983

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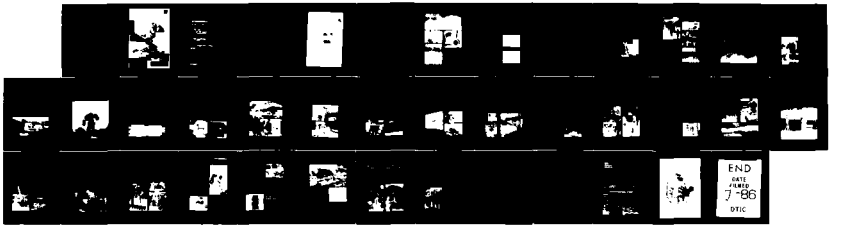

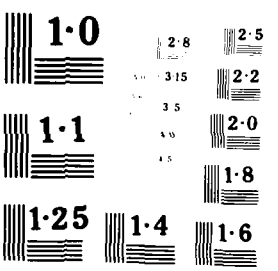
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Defence Science and Technology Organisation
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Cover

Anti-clockwise from the top left

- *Materials Research Laboratories designed and assembled this computer generated camouflage pattern for Australia, and subsequently tested the uniform materials for dyeing and colour fastness, as well as wear and tear.*
- *Jindalee over-the-horizon radar is being developed for Australian conditions and showing great promise in the surveillance of a large part of NW Australia.*
- *Gun gun — see Weapons Systems Research Laboratory section of the text.*
- *Particulate contamination of oils — see Materials Testing Laboratory section of the text.*
- *Soldiers: photograph of Mirage model in a Weapons Systems Research Laboratory wind tunnel: a technique which makes shock waves visible for models in wind tunnels.*
- *Trials of the Barra sonobuoy which has made significant advances in the detection and location of submarines. The RAAF accepted buoys from the first production contract in 1988/89. The UK which has already placed an order for 50000, designed the advance audio processing equipment for the system, and Australia developed the buoy.*

Back Cover

- *Kilsby's Hole near Mt Gambier, which is a sinking site with very clear water and little turbulence, is used for conducting diving and underwater behaviour of sonobuoys. Cameras, which are co-ordinated with a specially constructed acoustic ranging system, record trajectory information at regular intervals of depth below the surface.*

This information booklet was prepared by DSTO External Relations Branch, Department of Defence, Campbell Park Offices, Canberra, ACT 2600 (062) 66 4305

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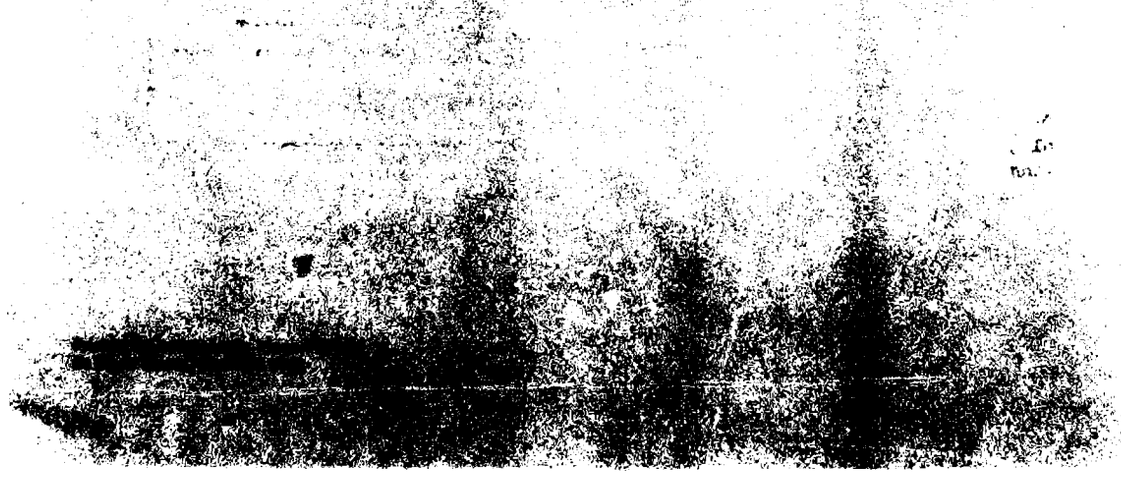

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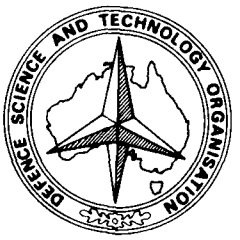

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Defence Science and Technology Organisation

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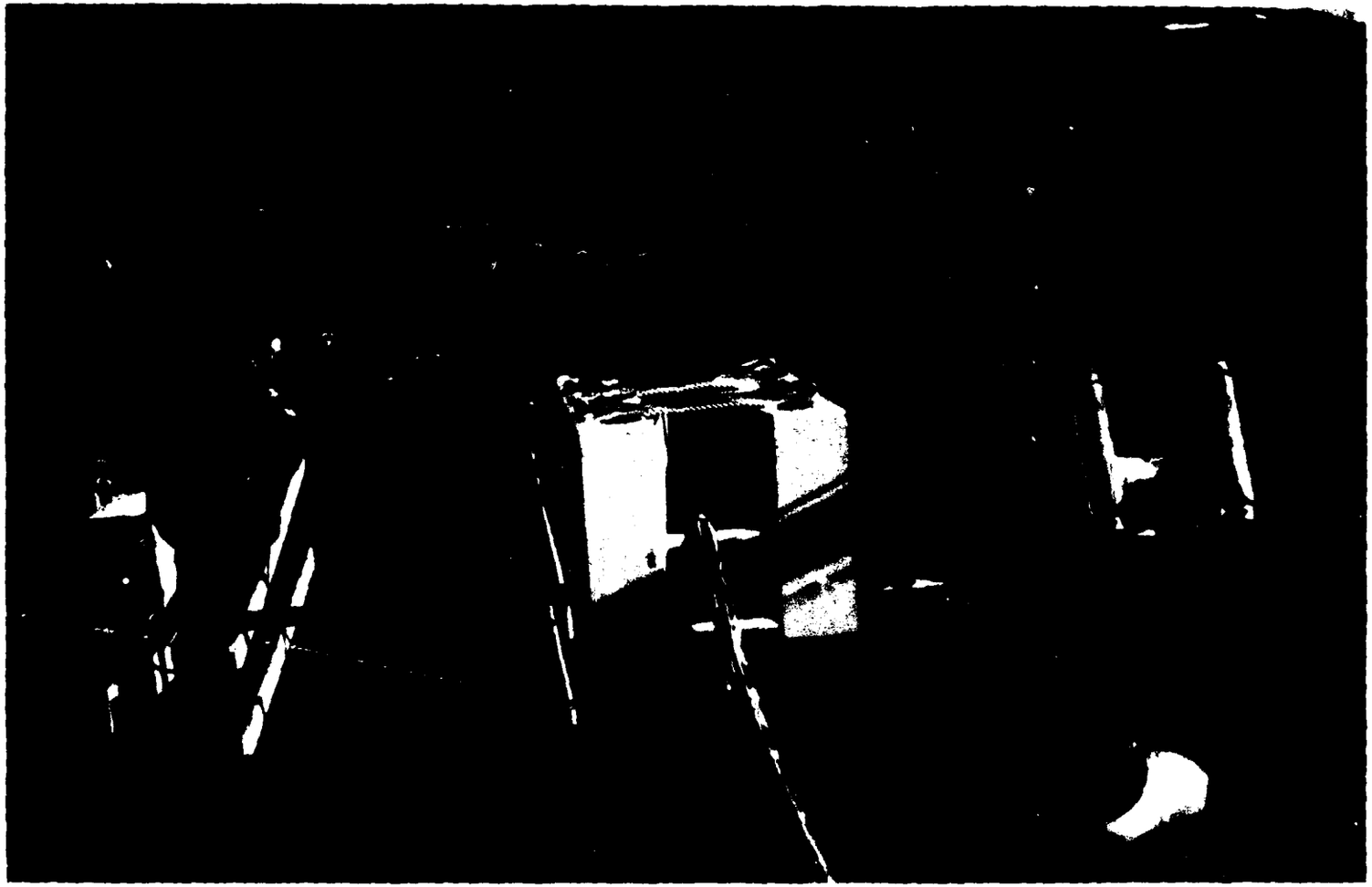
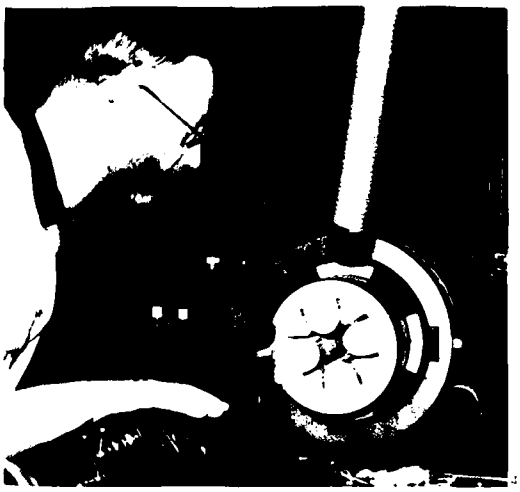


A measure of DSTO's effectiveness can be traced to its contributions to, and co-operation with an extensive network of international scientists. This photograph is of Boolee — a recent 5 year collaborative program involving Australia and the USA. Boolee studies used a towed acoustic array for long range detection of shipping.

Contents



1. *RAAF Mirage fighter fitted with a modified nose cone and gust probe designed by DSTO's Aeronautical Research Laboratories. Pressure transducers in the probe measure components of atmospheric turbulence during flight in rough air, and these are compared with airframe responses measured by strain gauges installed during manufacture.*

2. *Much military equipment has to be specially designed or modified for the Australian environment. Materials Research Laboratories has researched Australian camouflage problems — including durability and effectiveness under a wide range of topographical, seasonal and vegetation conditions — from dry sclerophyll eucalypt to tropical rainforest. Here a landrover is concealed under a Materials Research Laboratories designed camouflage net.*

3. *On behalf of Navy, detailed studies of the materials for use in the Minehunter catamaran have been made to assist the industrial contractors. Here a section of the glass reinforced plastic hull is being prepared for shock testing.*

4. *Assessment and extension of life of military equipment is an important part of DSTO's work. A member of the Propulsion Systems group at Weapons Systems Research Laboratory is here machining a Matra rocket motor propellant charge for studies associated with missile service life assessment.*

THE DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION

Introduction

The Defence Science and Technology Organisation (DSTO) in the Department of Defence exists to help the Australian Defence Force take best advantage of modern technology. This booklet provides information about DSTO and the activities of its laboratories. The relationship of DSTO with external science is also discussed. Names of laboratory and group leaders are given to facilitate some increased interaction with other Australian scientists and technologists.

DSTO is the second largest research and development organisation in Australia. There are some 1000 professional scientists or engineers in its total staff of about 4400. The current annual operating costs of some $140M is about 3% of the defence outlay.

DSTO has a central office in Canberra, representatives in London and Washington, and ten laboratories in South Australia, Victoria, NSW, ACT, Tasmania and Queensland. The Chief Defence Scientist, Professor P.T. Fink, CB, CBE, FTS, is the head of DSTO, and is supported in the central office by a deputy, Mr G.E. Barlow, and policy and management staff.

DSTO has the Defence Force and defence industry as its principal customers. The work of DSTO is directed to meet the needs of Australian defence, present and future, and there is considerable interaction between DSTO, the Defence Force and defence industry. Scientific advisers are attached to Service headquarters in Canberra and some field headquarters.

Despite DSTO's strong alignment with defence, unique DSTO skills and facilities are available for non-defence tasks if defence priorities permit. Interactions between DSTO staff and other workers in their fields are encouraged.

Role and activities of DSTO

The major activities of DSTO in helping Australia to make best use of modern technology in defence are

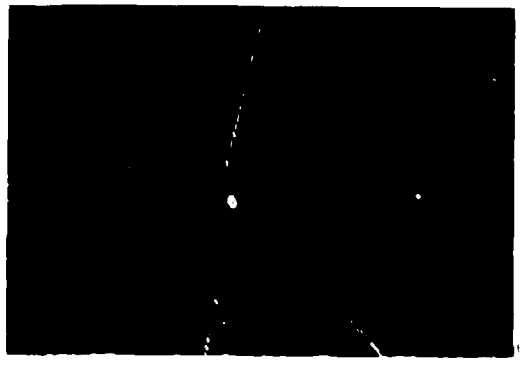
- scientific/technological input to formulation of defence policy,
- support in the choice, use and maintenance of equipment,
- investigation of Service problems where special features of the Australian physical or military environment are concerned,
- prototype development of selected equipment, usually for requirements peculiar to Australia (where practicable, engineering development is passed to industry),
- support for, and technology transfer to, defence industry,
- studies, trials and exercise analysis,
- international co-operation in defence science and technology to keep abreast of overseas military technology – a significant component of our alliances,
- bridge building between civil and defence science, and
- maintenance of a technology base to support these activities.

A formal statement of DSTO functions is given inside the back cover.

The work of the laboratories extends across a wide spectrum of science, technology and engineering. Fields in which significant work is being done include

- aerodynamics
- aircraft lethality and vulnerability
- aircraft structures
- ammunition
- ballistics
- characterisation of the Australian physical environment
- communications
- computer electronics and computing
- computer-aided design
- corrosion
- countermeasures

5/6. *A significant contribution to explosives development by Materials Research Laboratories was minimising problems associated with cast TNT. Small additions of hexanitrostilbene can alter the crystal structure from large aligned crystals in the top photomicrograph to small randomly oriented crystals (below) which are more stable.*



- electronic warfare
- energy and fuels
- explosives
- fatigue of materials
- food sciences
- guidance and control systems
- infrared technology
- ionospheric physics
- lasers and electro-optics
- materials science
- microwave propagation
- microprocessor applications
- mycology
- oceanography and ocean engineering
- optics
- pharmacology
- physiology
- polymer chemistry
- propellants
- radar
- radio communications
- rocket motors
- satellite communications
- sonar
- systems, systems modelling and integration
- trials and evaluation of defence equipment and stores

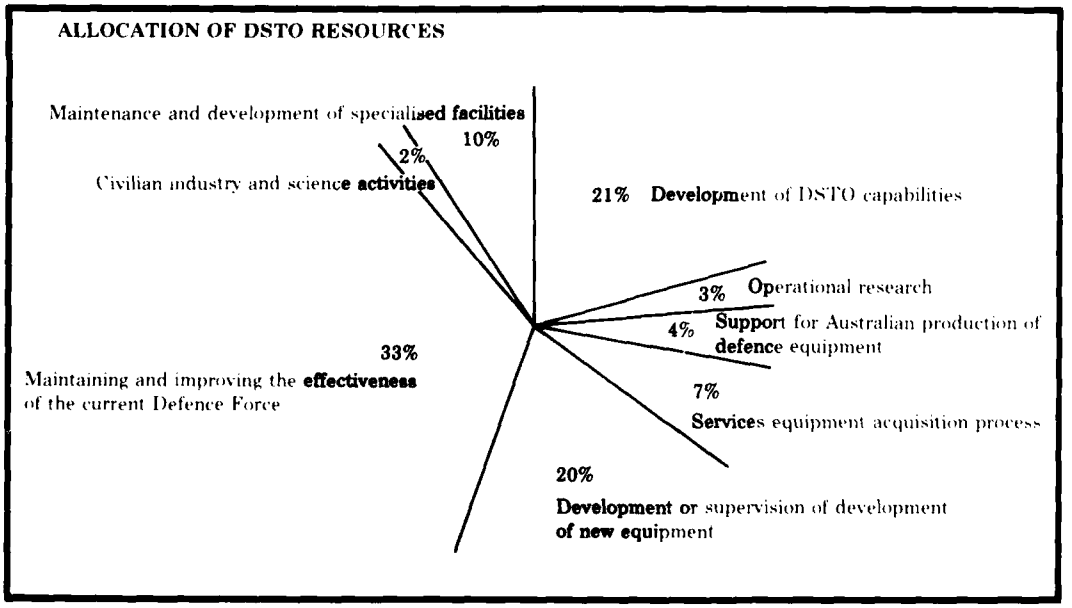
together with analytical and operational research studies on matters such as logistics, manpower, sensor and weapons systems, and strategic-tactical options and force mixes.

DSTO is perhaps best known for the major projects developed to meet specialised Australian requirements, eg, the Jindalee over-the-horizon radar, Mulloka ship sonar, Barra sonobuoy and Ikara long range anti-submarine weapon. Although these are important, tasks associated with the development of new equipment represent only about 20% of DSTO internal work (where practicable development is contracted out). The diagram below shows a breakdown of DSTO effort.

Forward planning and program control

Each year DSTO prepares a rolling five year research plan showing the proposed allocation of resources to 29 areas: eg, Aircraft and Air Operations, Surveillance of Underwater Targets. This plan is based on inputs from

- laboratory scientists and engineers,
- Service operational and engineering staff,
- central policy staffs (Service, scientific, strategic, industry and finance).



The DSTO five-year plan is one input to defence's total five-year rolling program. During the formulation of the latter, the planned level of total DSTO resources is determined in competition with other demands on the defence funds.

The finally agreed DSTO plan shows desired trends in the resources allocated to each area. However there is flexibility to accommodate significant unforeseen developments.

Approval of individual research tasks consistent with the plan is decentralised as far as is practicable. Approval of larger tasks requires formal consultation with the Services and other divisions of the department, while very large tasks such as Barra and Jindalee require separate government approval. Typically in a year DSTO takes on over 200 larger tasks (each requiring more than one professional man year of effort plus necessary support) and several thousand smaller tasks (many in the form of consultancies).

Interaction with other science and technology

DSTO encourages contacts between its staff and R&D workers in industry, government and tertiary educational institutions where there is mutual benefit. DSTO has cooperated in staff exchanges, arrangements for study leave at DSTO laboratories and staff secondments and is willing to consider further proposals. Special DSTO skills or facilities not available elsewhere in Australia can be used by the non-defence community if priorities of Defence tasks permit.

Some Defence Research Groups are being set up under DSTO sponsorship. These groups gather in R&D workers from industry, tertiary educational institutions, defence and other government laboratories for discussions, symposia etc. in some specialised areas, and encourage coordination or sharing of research tasks. For example, there are groups on performance of structural adhesives, and in marine geophysics with emphasis on the interaction of sound with the sea floor.

For obvious economic reasons Australia buys most of its major items of defence equipment overseas. Hence we have much less need than for example the United States to engage in, or contract out, strategic mission oriented research that might lead to new weapon systems concepts or technologies. Nevertheless DSTO has a modest program of research contracts with tertiary educational institutions and this is growing. Examples include signal processing, dynamics of, and noise generated by, long towed acoustic arrays, aircraft gust load statistics, strength degradation of brittle ceramics, magnetic materials and growth of single crystals for electro-optic applications.

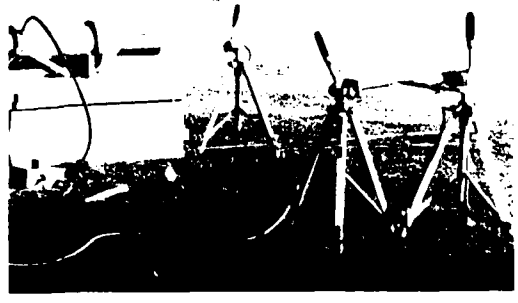
While results of classified research have limited distribution, much unclassified work is available to the wider scientific and technological communities through the usual means of publication of papers, participation in conferences and learned societies, and interaction with professional peers. Some three-fifths of DSTO publications are publicly released.

Much of DSTO's classified work is made available to defence scientists and technologists in USA, UK, Canada and New Zealand under the auspices of a collaborative R&D agreement with these countries known as The Technical Co-operation Program (TTCP).

TTCP aims at sharing information to encourage collaboration between members and to avoid unnecessary duplication. DSTO participates in 64 of the 69 TTCP working groups which cover most of non-nuclear defence science.

In a number of areas there is collaborative work arising from international agreements; for example DSTO's large experimental Jindalee over-the-horizon radar program maintains contact with the US program through a series of 'workshops'. The UK joined the Barra program to develop an airborne processor matched to the Australian sonobuoy. The Barra sonobuoy was developed by DSTO and Australian industry and is now in production for both countries.

7. *Throughout his career Dr Samuels of DSTO's Materials Research Laboratories has taken an active interest in the problem of transferring technology from the laboratory to manufacturing industry, and in fostering the professional training of metallurgists. In 1980 The American Society for Metals honoured him with its highest award, recognising his pioneering work in physical metallurgy — especially in relation to caps and the mechanisms of machining and grinding.*



INTERACTION WITH OTHER SCIENCE AND TECHNOLOGY

Apart from participation in international scientific research networks, many DSTO scientists and engineers are active in science and technology committees, institutes and learned societies, as well as acting as consultants and promoting the transfer of technology to industry.

8. *Working contacts with overseas scientists and participation in bilateral and multilateral defence research programs are important in keeping DSTO abreast of recent world developments. Australia's National Leader of The Technical Co-operation Program panel on Space Communications (centre) is being briefed on the experimental EHF Satcom terminal at US Army Satcom Agency Fort Monmouth (New Jersey).*

9. *Work on the use of nitroguanidine/TNT as an insensitive high explosive has been well received in an international collaborative program. The effectiveness of this material as a shell filling was assessed using the target arrays shown here set up for a Materials Research Laboratories trial.*

10. *Contracts with industry have grown considerably in recent years. Laser power-output is here being measured at Quentron Electronics Pty Ltd Adelaide, using a Scientech calorimeter. Weapons Systems Research Laboratory provided technology transfer assistance to build this laser system in Australia with about 80% Australian content (on a cost basis).*

11. *Loss of hearing is a medical and a communication problem for gunners as well as civilian workers in some occupations. The high level impulse noise generator shown here being tested at Victoria Barracks Sydney, was developed at Advanced Engineering Laboratory for use in a study by the National Acoustic Laboratories. Sudden expansion of dry air during operation causes water vapour to condense from surrounding air as evident in this photograph.*

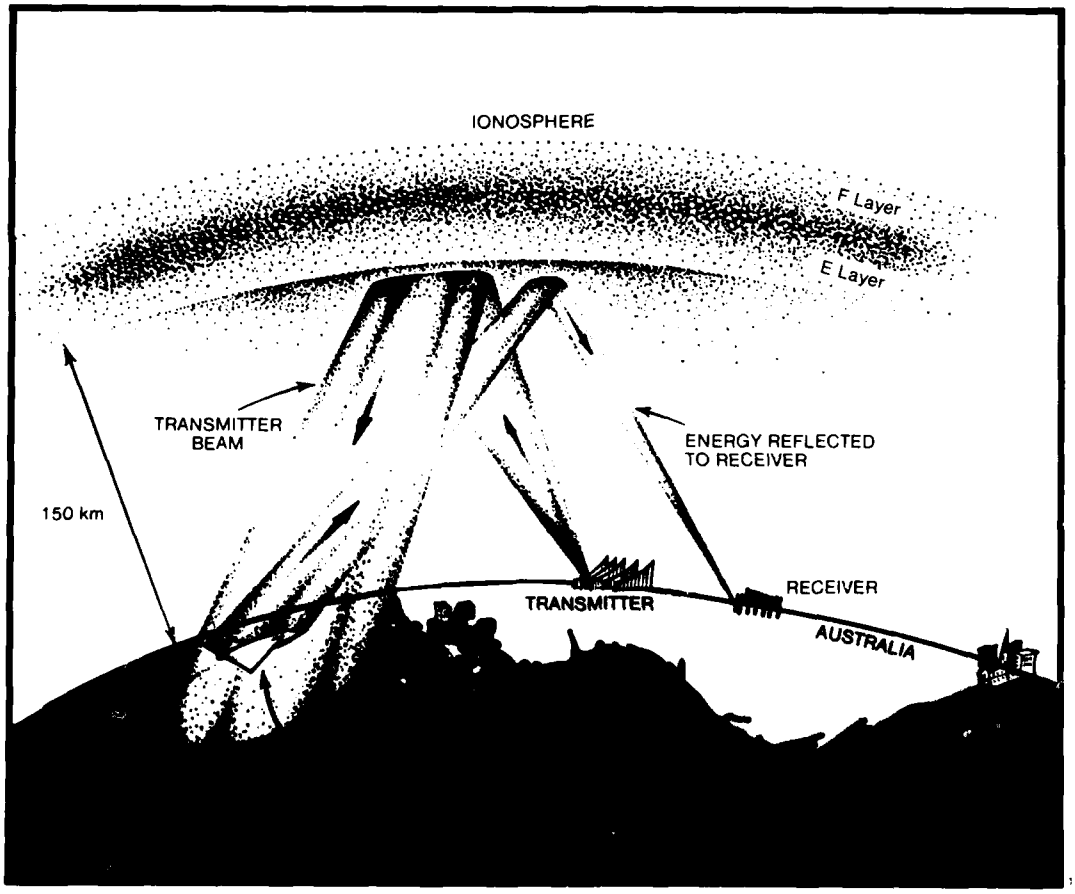
In-house or not in-house?

Australia has been criticised for having too much of its R&D in government and too little in industry, and the Commonwealth government recently stated its intention to increase the proportion of its R&D done in industry.

For some time it has been DSTO policy to contract to industry, wherever possible, development work on projects likely to lead to volume production. DSTO tries to involve industry as early in the project as is practicable but needs to have sufficient competence internally to provide 'research and development authority' supervision. Four projects (Ikara long range anti-submarine weapon system, Barra sonobuoy, Mulloka sonar and the Karinga cluster bomb) originated in DSTO and developed in Australia have led to contracts in industry valued at $50M for development and $320M for production (including $140M in exports). However as noted before, for economic reasons much of Australia's major defence equipment is not developed in Australia.

Australia's grasp of new defence technology is considerably assisted by information from our international partners through TTCP (described above). To protect proprietary interests, TTCP information exchanges are largely confined to those between government scientists of each country. It would not be possible to obtain the substantial benefits Australia now reaps from TTCP without a good in-house capability.

12/13. *Two outstanding Australian initiated projects are the Jindalee over-the-horizon radar, and the Barra sonobuoy for submarine detection. Barra (overleaf) has resulted in development contracts to industry of $44M. There has been $11M in installation, development, operation and maintenance contracts to industry for Jindalee up to its present stage of development.*



Acquisition of defence equipment involves very large expenditures and there may be technical risks. Before making a decision the government requires scientific and other advice independent of any commercial interest. Again an in-house capability is required.

The Defence Industry Committee — a group of senior industrialists and departmental officers set up to advise the Minister for Defence — recently reported on 'Industry Participation in Defence R&D'. The committee sought to identify those R&D tasks which arise from defence sources and are suited to industry. The committee concluded that most of such tasks 'are associated with development' and 'as the majority of such tasks carried out in Australia are already contracted to industry the scope for increasing industry participation from these sources is not great'.

The committee also noted that for most of the tasks suitable for industry 'it would be necessary for the DSTO to first define the R&D requirement or to specify the technical base and standards'.

In elaborating on the types of tasks suitable for industry the committee stated

'Whilst no set of guidelines can completely eliminate the need for examination of individual cases, it was felt that the majority of such tasks fall within the following categories:

(a) development of systems and subsystems, leading to eventual production;

(b) development of facilities in specific processes or technologies;

(c) development of technologies;

(d) project definition studies leading to acquisition;

(e) design studies and system integration;

(f) research related to production tasks where economies of scale are relatively favourable.'

In summary DSTO must inevitably keep a good deal of expertise in-house but it recognises a need to contract out some R&D. Indeed for the years for which comparative data have been published* Defence R&D contracting out to industry was 5.2, 1.3 and 2.9 times that of the total of all other Commonwealth departments and agencies doing in-house research, when measured as a proportion of in-house R&D budget.

DSTO reviews

In line with Commonwealth government policy to review its major research organisations, DSTO was the subject of review in 1980. The reports:

- Independent External Review of the Defence Science and Technology Organisation Report, October 1980
- Internal Review into Objectives and Procedures of the Defence Science and Technology Organisation, October 1980

are published by the Australian Government Publishing Service.

The Minister for Defence announced the government response to the reviews' recommendations on 29 July 1981. Many of the recommendations concerned the organisation, management and administration of DSTO, and were aimed at streamlining its operations. Some recommendations aimed at enhancing relations with industry and external science. The Minister agreed that scientists in government service required special working arrangements if innovation were to flourish and the government accepted most of the recommendations. Some relating to organisation, were referred to the Defence Review Committee which reported on 28 October 1982.

*ASTEC, *Industrial Research and Development: Proposals for Additional Incentives* (AGPS, Canberra, 1980) Table C2 (1978-79);

Minister for Science and Technology, *Science and Technology Statement 1981-82* (AGPS, Canberra, February 1982) (1980-81 and projected 1981-82).

THE LARGER DSTO ESTABLISHMENTS

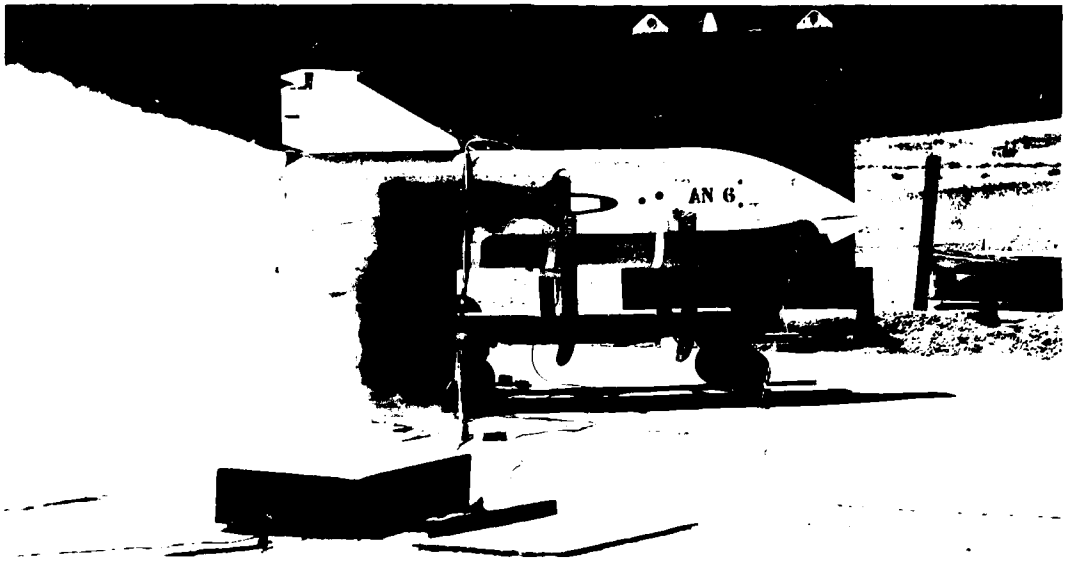
A brief history

Materials Research Laboratories began life as the Chemical Adviser's Laboratory at Victoria Barracks, Melbourne in 1910. It moved to Maribyrnong in 1922 under a new name. During the 1939-45 war (by which time it was Munitions Supply Laboratories) it expanded tenfold and worked closely with rapidly expanding secondary industry to produce war materiel. From 1945 to 1949 it helped industry make the transition to peacetime manufacture. In 1949 it became part of the Department of Supply, as Defence Standards Laboratories. The support given to industry was reduced and a greater effort put into defence R&D. In 1974 this establishment and most other laboratories in the Department of Manufacturing Industry (formerly Supply) were transferred to the Department of Defence, and DSTO came into existence. At about the same time the Departments of Navy, Army and Air were integrated into the Department of Defence.

Aeronautical Research Laboratories was formed in 1939 as the Division of Aeronautics of CSIR, at Fishermen's Bend, Victoria, becoming ARL on moving to the Department of Supply in 1949. Early work was concentrated on wartime problems in aerodynamics, engines and fuels, and structures and materials. The post-war period to the early sixties saw a much lower level of military and industrial demand and there was a greater effort in basic research. During this period many of the professional staff gained overseas experience and many of the present broad streams of activity were initiated.

Following the conclusion of an agreement between the governments of Australia and United Kingdom, the Long Range Weapons Establishment was set up in 1947 at Salisbury South Australia, by the Department of Supply, in order (mainly) to support the development of a missile-testing range at Woomera. Over the next few years many young Australian scientists and engineers were trained in UK defence science establishments. In 1949-50 some of the activities at the Aeronautical Research Laboratories (Melbourne) were transferred to Salisbury and set up as the High Speed Aerodynamics Laboratory. In addition the Propulsion Research Laboratory and the Electronics Research Laboratory were formed at Salisbury. In 1955 the four bodies were fused into the Weapons Research Establishment. During the sixties and early seventies there was a progressive transfer of effort from developing and using the Woomera range to performing R&D in support of the Australian armed forces, notably in the fields of communications, radar, mathematical modelling of weapon systems and aircraft, electronic warfare, and optical and infrared technology. In 1978 (after the general movement of laboratories into the Department of Defence in 1974, and the formation of DSTO) the Weapons Research Establishment was split into the Advanced Engineering Laboratory, the Electronics Research Laboratory, the

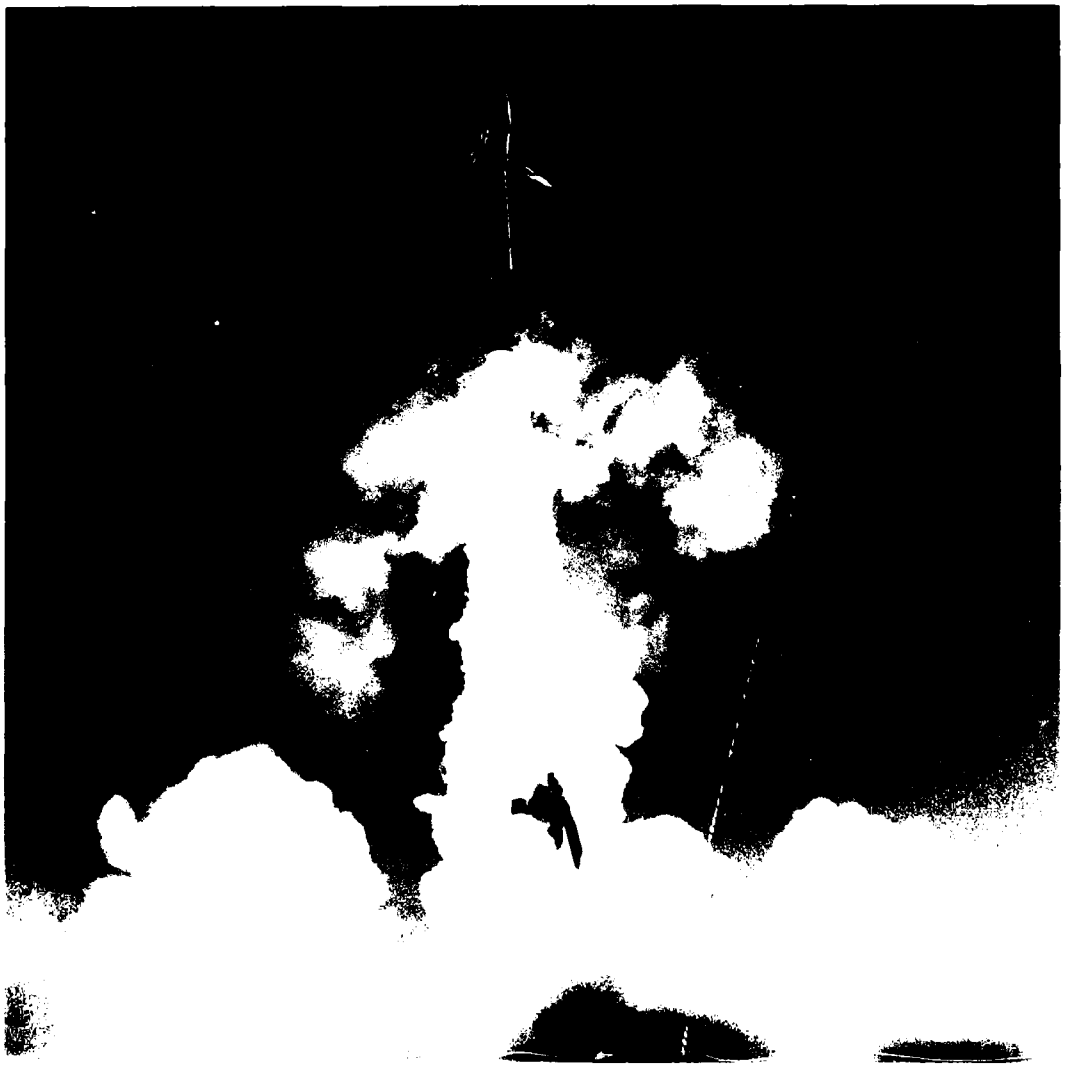
1. *One of the most enduring successes of Australian defence science has been the long range anti-submarine weapon system, Ikara, which is installed in ships of the Australian, British and Brazilian navies. With updates over the last 2 decades Ikara is still attracting overseas sales enquiries, and has earned Australia over $110M. The picture shows testing at Army's proving range at Graytown of an igniter rig tie down fixture for Ikara.*



Weapons Systems Research Laboratory and the Trials Resources Laboratory. The Trials Resources Laboratory was absorbed into the Advanced Engineering Laboratory in February 1982. The three laboratories at Salisbury are known collectively as the Defence Research Centre Salisbury (DRCS).

The integration of laboratories and separate Service departments into the Department of Defence, in 1974, brought the scientists and engineers of DSTO into closer contact with the armed forces and led to an increased concentration on shorter term specific defence problems.

2. *Woomera range, developed for rocket research following World War II, has played a leading role in the development of Australian defence science. Although an extensive upper atmosphere research program ceased in the early 1970s and the UK/Australian Joint Project came to an end in 1980, Woomera's facilities (now maintained at care and maintenance level) are able to be activated for trials of defence equipment when needed. This high altitude research vehicle pictured, is leaving the launcher during a Joint Project trial at Woomera in 1979.*



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Advanced Engineering Laboratory

Director: Mr J.E.H. Lamprey
GPO Box 2151, Adelaide, SA 5001;
telephone (08) 259 9111;
Location: Defence Research Centre Salisbury, SA

Advanced Engineering Laboratory (AEL) engages in engineering feasibility studies, and the development, design and manufacture of prototype systems and equipment in the mechanical and electronic engineering fields. It also provides engineering support to the Services and assistance to defence-related industry. AEL works on advanced manufacturing techniques and processes, carries out environmental testing, and provides engineering and workshop services to the other laboratories at Salisbury. R&D is undertaken to maintain an advanced engineering technology base. It also applies its expertise to the planning, conduct and analysis of trials and exercises at Woomera and elsewhere. The staff of 1200 includes 150 professional officers (140 of them engineers) and 500 workshop personnel. The annual operating budget is about $27M.

Communications and Electronic Engineering Division is led by Mr R.D. Ramsay. The communications systems engineering groups under the direction of Mr R. Paterson comprise

- switching and networks — Mr R. Shoubridge
- communications technology — Mr F.B. Andrews
- radio communications — Mr T.C. Wollaston

Mr E.C. Lawson is responsible for the electronics engineering design groups

- digital systems engineering — Mr P.L. Silver
- control and instrumentation systems — Mr A.C.O. Gibb

In underwater systems engineering, led by Mr J.I. Renton, the groups are

- underwater systems development — Mr J. McKibbin
- sonar engineering — Mr D.J. Whitford
- instrumentation design and development — Mr L.L. Anderson

Mechanical Engineering and Workshops Division is led by Mr B.F. Rush. Mr A.F.W. Langford is responsible for the mechanical engineering design groups

- mechanical and fluid systems — Mr J.S. Gilbert
- mechanisms and instrumentation — Mr J.A. Ellershaw
- mechanical systems analysis — Mr R.N. Smith

Air systems engineering under the direction of Mr G.B. Wheaton comprises

- air weapons development — Mr D. Anderson
- air systems analysis — Mr J.O. Bolton
- airborne structures and instrumentation — Mr P. Roberts

In Workshops, led by Mr G. Helliwell, the groups are

- electrical and mechanical workshops — Mr R.C. Kuhne
- electronic workshops — Mr J. Connell

Trials and Technology Support Division is led by Mr D.J. Bennier. Mr J.G. Rodger is responsible for trials, an instrumentation systems group and a

- planning and data analysis group — Mr G.M. Ziesing

In engineering and technology support the groups under Mr J.B.M. Stradling are

- computer aided processes — Mr G.J. Marsh
- quality assurance — Mr A.J. Seager

3. *A field automatic message switch (Fams) developed by the Communications and Electronic Engineering Division in AEL, introduced into Australian field operations for the first time a computer based store and forward message switch. AEL constructed these two air-conditioned shelters which contain computers, tape recorders, control consoles and maintenance support equipment. Fams can handle up to 2500 incoming and 5000 outgoing telegraph messages per day, at different levels of precedence and security.*

• drafting and graphic services — Mr C.K. O'Donnell

Mr J.E. Pearce is responsible for the environmental engineering facility.

AEL's areas of work include microelectronics, control systems, computer techniques, communications, electro-optical mechanisms, ocean and airborne systems, aerials, and pneumatic and hydraulic systems. Design and development may be taken from a feasibility study stage through to the conclusion of experimental or prototype equipment testing and evaluation, together with the assembly of data packages for use in the subsequent manufacture of the equipment by industry. Modern interactive computer systems are available to staff engaged in system simulations, design calculations, circuit layouts and automated drafting. Environmental, laboratory and field testing and evaluation are undertaken using computer techniques to gather, reduce and analyse data.

Experimental and prototype equipments are manufactured using a wide range of modern machine tools and processes, including instrument making, precision metal fabrication and finishing, and casting and plastics fabrication. Thick and thin film processes including photolithography under clean room conditions are used in the micro-engineering manufacture of hybrid-circuit, surface-acoustic-wave, strip line, graticule and encoder devices. Chemical milling, electroplating and forming processes are used in making mechanical components and printed-circuit and multi-layer boards. Computer control is commonly applied to these manufacturing processes (and digital data generated at the design or drafting stage is transferred directly to manufacturing and process equipment) to inspection, and to planning and resource scheduling, costing, maintenance control, and information services.

The Trials Branch has three main functions

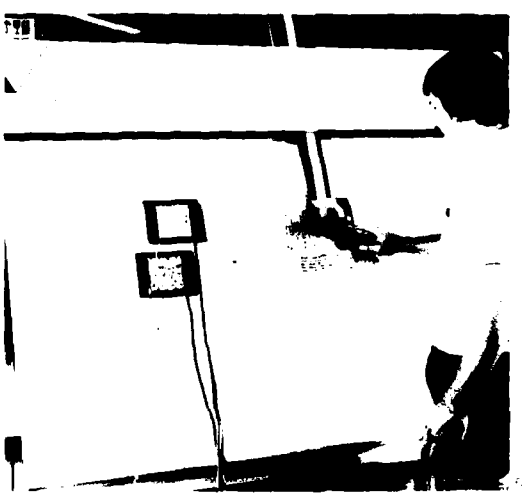
- to plan, instrument and conduct R&D trials at Woomera and elsewhere and reduce the data (note that the Woomera range is manned only as required)
- to plan and conduct analyses of Service (mainly RAAF) exercises anywhere in Australia.
- to undertake R&D in the associated fields of electronic optical instrumentation, data processing systems and techniques.

It is concerned with the development and maintenance of the instrumentation and facilities at Woomera for recording the trajectory and performance of weapons released over an area of approximately 300 sq km. The primary instrumentation includes 2 C-band tracking radars, 10 Contraves kinetheodolites, and long-focal-length tracking cameras. It also has kinetheodolites and instrumentation cameras available for use on trials anywhere in Australia. Data reduction facilities are developed and maintained for both film and tape records, which interface with the DRCS computer.

Emphasis is being placed on co-operation with, and technology transfer to, industry, in particular in the areas of development of new military equipment and of 'offset'

4. *Defence engineering design often involves precision machining. Here a small servo-damper spring is being turned on a jeweller's lathe. The spring, produced for the F111 terrain profiler's hydraulic system from a single piece of material has a shaft of 12mm with a diameter of .5mm and a terminal .75mm ball with true sphericity of half a micron or better.*

5. *Computer aided design and manufacture using modern interactive computer systems, is widely used by DSTO research and design engineers, draftsmen and technical staff. Digitising a micro-electronic layout drawing, the initial stage in computer aided design, is shown*



manufacture. As far as is possible industry is involved in the early R&D phases of new military equipment, to help develop the competence needed for continued involvement through further development, design, production and support phases. In the 'offset' area, AEL has helped industry to undertake work under the Australian Industry Participation program. In addition, companies have been helped to assess the viability of making use of specific pieces of advanced technology in the manufacture of their products.

Recent major development projects in which AEL has taken part include the Barra sonobuoy, the Mulloka sonar and the Karinga cluster bomb. In addition to playing a major part in developing the sonobuoy, AEL developed

6. *The Australian developed Karinga cluster bomb, is shown being loaded onto a F111C aircraft. Several DSTO laboratories including AEL combined in the conception, design and development of Karinga. Related R&D contracts with government factories and other industry total nearly $9M.*

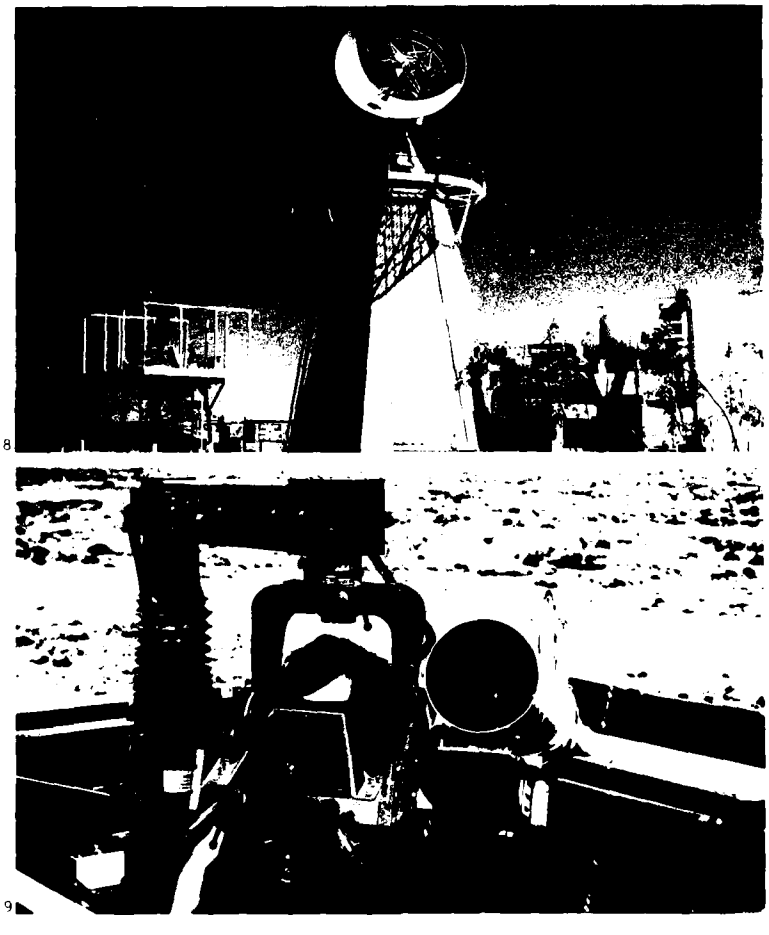
7. *Mulloka is Australia's first venture into the design and manufacture of ship mounted sonars. DSTO's AEL and RAN Research Laboratory developed Mulloka, which includes the most up to date technology in solid state electronics and automatic signal processing. Research in underwater acoustics propagation at high frequencies in waters neighbouring Australia was also necessary. Mulloka contracts to Australian industry have amounted to $40M. Here a Mulloka transducer element is being refurbished.*

6

the instrumentation system for a range at Jervis Bay which is being used for testing the operation at sea of production buoys.

AEL has undertaken a feasibility study on the development and production in Australia of a laser range-finder for the Mirage aircraft of the RAAF, work on Electronics Research Laboratory's laser airborne depth sounder (Lads) and digital data transmission at 2400 bit/s over an HF radio link using real-time ionospheric-sounding frequency management (in co-operation with Electronics Research laboratory and RAAF). Other work has included the protection of underwater sonar transducer elements from sea-water ingress, development of a sea-going articulated crane, development of a noise generator for National Acoustic Laboratories, and the design of an instrumentation probe for the measurement of attitude and acceleration in the elevation and yaw planes of an F111C aircraft. It has applied a computer model of the defence telegraph communications network to provide dimensioning for a network traffic switch, constructed two interim field automatic telephone switches for Army, and studied the feasibility and limitations of a manportable satellite communications terminal, the performance of 8 GHz communications links in the tropics, and UHF transionospheric scintillation fading.

8/9. *The Trials and Technology Support Division of AEL has the expertise to mount full scale trials at Woomera and elsewhere. Australia has invented some special trials instrumentation and recording techniques, and Woomera has a significant history as a rocket and testing range which dates from the 1940s. It was from Woomera that Australia launched its only satellite in 1967, and a number of joint international rocket and missile launchings took place until the 1970s.*



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Aeronautical Research Laboratories

Director: Dr G.L. Brown
Fishermen's Bend, Victoria; telephone (03) 647 7511
PO Box 4331, Melbourne, VIC 3001

Aeronautical Research Laboratories (ARL) has a professional staff of about 200 and an annual operating budget of $13.5M.

Aerodynamics Division, led by Mr R.L. Brooks assisted by Dr D.C. Collis, carries out research in subsonic and transonic aerodynamics and studies of control and stability problems of military aircraft including the influence of automatic flight control systems. The division operates subsonic and transonic wind tunnels (there are supersonic wind tunnels at Weapons Systems Research Laboratory, Salisbury, South Australia). Extensive tests have been conducted in these tunnels for all Australian defence projects requiring aerodynamic data, including Jindivik, Malkara, Ikara, Turana, Nomad and Karinga. Recent work has included tests of the Mirage III and F111C aircraft to provide data for mathematical models, studies of these aircraft, tests on advanced transonic aerofoils, investigations of the F111 cockpit ejection motions, development of modifications to Nomad aircraft, and investigations of exhaust smoke, flow separation and steering problems in naval vessels. Mathematical models have been developed of the flight dynamics of Mirage III-O, F111C, Wessex and Sea King Mk 50 aircraft. Advanced system identification methods are being applied to the analysis of flight test data and a study is being made of aircraft handling qualities. Areas of expertise and group leaders are

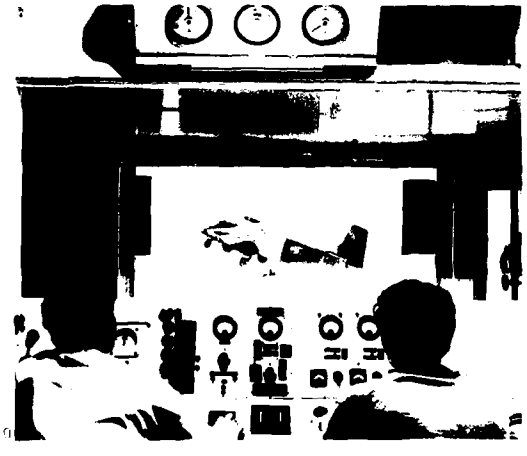
- rotary-wing aircraft behaviour studies — Mr N.E. Gilbert
- fixed-wing aircraft behaviour studies — Mr D.A. Secomb
- aerodynamics research — Ms D.A. Lemaire
- wind tunnels research — Mr N. Pollock
- wind tunnels operation — Mr T.H. Trimble
- instrumentation and field experiments — Dr G.P. Rundle

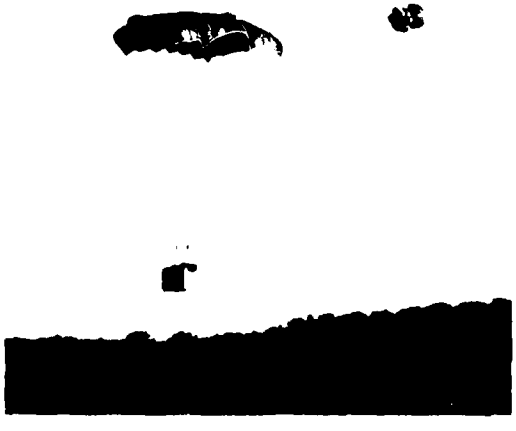
Materials Division, under the leadership of Dr F.P. Bullen, carries out research on aircraft materials, particularly on deterioration in service, its detection and consequences and remedial actions. There is work on non-destructive methods of inspection (including acoustic emission testing) for critical regions that will permit the periods between major overhauls to be extended. Research by Materials Division and Structures Division on carbon- and boron-fibre-reinforced plastic materials and structural adhesives has led to the development of effective and cheap crack-patching techniques. These are now being applied to repair and inhibit stress corrosion and fatigue cracking in RAAF Mirage, F111C, Hercules and Macchi aircraft. The groups and their leaders under Dr Bullen and Mr J.H. Auld are

- structure of materials — Mr I.G. Scott
- reliability assessment — Mr L.M. Bland

10. *DSTO facilities and capabilities are available for use by external bodies in government and industry when defence commitments permit. ARL wind tunnel staff are shown measuring aerodynamic forces on a 1/10th scale model of the Government Aircraft Factories' stol aircraft Nomad.*

11. *ARL produced a research model of a remotely steered parachute and stores container, designed to accompany and be controlled by a free fall parachute team. Production prototypes have been prepared by industry under contract. This picture shows the radio controlled parachute landing with a 150kg stores container during development trials.*





- metals technology — Dr N.E. Ryan
- non-metals technology — Dr A.A. Baker
- chemical properties — Dr T. Mills
- mechanical properties — Dr B.J. Wicks

Mechanical Engineering Division, led by Mr D.G. Stewart assisted by Mr F.H. Hooton, works on air-breathing propulsion systems and engine-airframe integration and performance. Emphasis is being placed on the determination of mechanical aspects of loading histories, low cycle fatigue, predictions of safe life, and those non-destructive methods of maintaining good condition termed 'engine health monitoring'. Research into engine component performance has continued, especially on intakes, combustion systems, compressors, turbines and afterburners. Recently Government Aircraft Factories was helped with an investigation into the performance of the anti-icing system of the Nomad aircraft engine and with testing a redesigned system. The availability of aviation fuel in the future was recognised some years ago as a potentially serious defence problem, and this division and Materials Research Laboratories have together conducted a review of alternative sources of fuel, including the prospects of obtaining fuels from cultivation of the alga, Botryococcus braunii. The groups are

- propulsion aerodynamics and special projects — Mr S.A. Fisher
- combustion research — Dr W.H. Schofield
- propulsive fuels — Dr L.W. Hillen
- propulsion thermodynamics — Mr D A. Frith
- propulsion mechanics — Mr C.N. King
- propulsion instrumentation and trials — Mr K.F. Fraser

Structures Division, headed by Dr G. Long assisted by Mr J.Y. Mann and Mr B.C. Hoskin, performs research into the structural integrity and efficiency of aircraft — particularly work on structural mechanics, lethality and

12. *RAAF and ARL officers inspect a Macchi wheel which has been repaired with boron-fibre-reinforced plastic patches. ARL have pioneered highly cost-effective and structurally efficient repair schemes for five RAAF aircraft. The repair of cracked wing skins in the Mirage fleet resulted in savings of several million dollars with negligible loss of operational availability of aircraft.*

13. *Aircraft fatigue data analysis system (Afdas) in service at Williamtown RAAF base. Afdas was developed from an ARL concept and design and is now in production with British Aerospace (Aust) Ltd. It uses strain transducers to enable a precise estimate of fatigue damage to be made without use of airborne data loggers and substantial ground processing facilities.*

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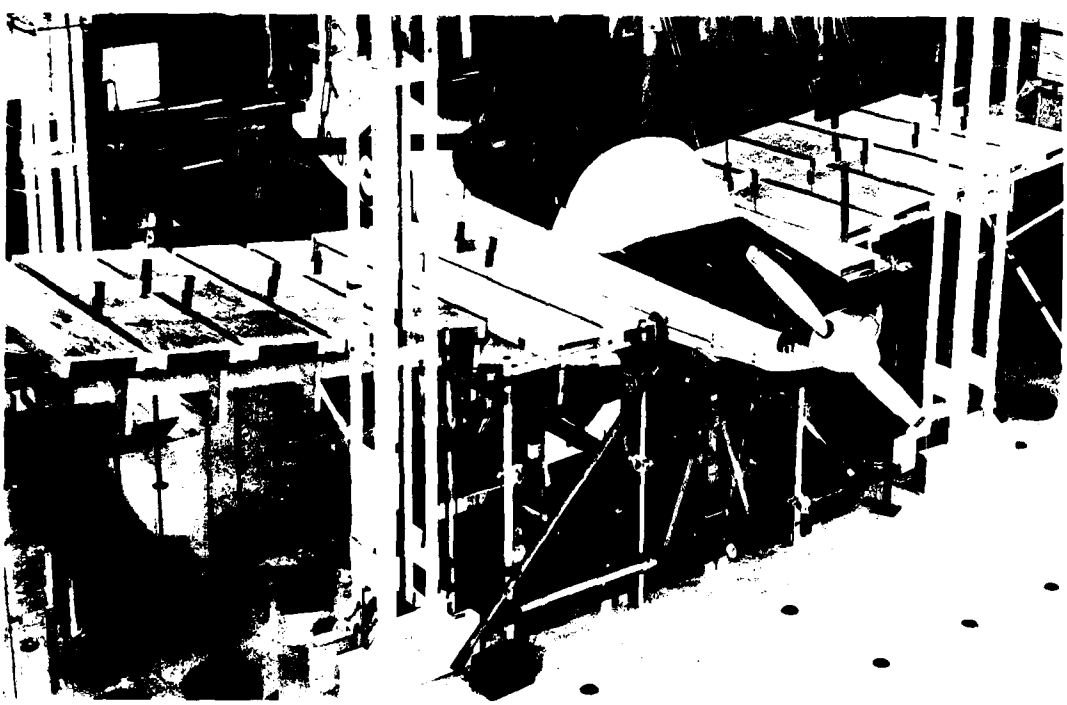
vulnerability, aero-elastic effects, fatigue life and operational problems. The division has carried out basic fatigue research for many years and its extensive fatigue-testing program has covered many Australian-operated civil and military aircraft. Its facilities are able to test complete aircraft in static load and fatigue conditions. The division's investigations of fatigue in the F111C, before its acceptance by the RAAF, caused the US Air Force to redevelop the wing-carry-through box and to replace many other components. Recently the division has developed refurbishment techniques for Mirage wing spars and, with Materials Division (qv), the use of boron- and carbon-fibre patching materials for extending the life of Mirage and other aircraft. The leaders of activities are

- structural mechanics and vulnerability — Mr J.L. Kepert
- vibration and aero-elasticity — Dr R. Jones
- life of aircraft structures — Mr C.K. Rider
- fatigue and reliability — Dr D.G. Ford
- fatigue of materials and components — Dr J.M. Finney
- structures experiments — Mr C.A. Patching
- structures instrumentation — Mr E.S. Moody

Systems Division, led by Mr J.M. Evans with the support of Mr A. Ross, was formed in 1965 from the nucleus of the Ikara guided weapon development team. The division still has significant Ikara responsibilities tarising from its role as R&D Authority for the flight vehicle, and as Coordinating R&D Authority for the complete weapon system and its variants) but is now more concerned with the operations of complete flight systems and sub-systems, and assessments of relative effectiveness of competing systems. Areas of work include the analysis of systems, operational studies, manned flight simulation, human factors, military anthropometry, navigation, statistical sampling and reliability. The groups and their leaders are

- operations research — Mr D.H. Spivakovsky
- flight simulation — Mr D.E. Hatton
- systems operations — Dr P.F. Preston
- cybernetics — Dr B.A.J. Clark
- combat effectiveness — Mr D.A.H. Bird
- projects and trials — Mr G.C. Quigg

14. *Structures Division draws on 40 years of expertise when conducting full scale structural testing for airworthiness and research purposes. Here a CT4 (basic trainer) undergoes load calibration before flight testing. Systems Division's Cybernetics group made extensive ergonomic appraisals for the cockpit and instrument configurations, canopy and lighting designs. Aerodynamics Division tested the CT4 in the subsonic and transonic wind tunnels*



14.

Electronics Research Laboratory

Director: Mr H.A. d'Assumpcao
GPO Box 2151, Adelaide, SA 5001;
telephone (08) 259 9111;
Location: Defence Research Centre Salisbury, SA

Electronics Research Laboratory (ERL) is concerned primarily with R&D in radar, radio, electronics, infrared physics, optics, electro-optics, electronic warfare, surveillance, and navigation. It is staffed by some 460 people, of whom about 160 are professional scientists or engineers, and has an annual operating budget of $16M.

Radar Division is led by Mr L.B. Soden. The groups in the division are

- Jindalee project — Mr W. Mettyear
- cybernetic electronics — Mr D. Lamb
- microwave radar — Mr B.S. Deegan
- Jindalee development — Mr C.T. Carson
- radio — Dr D.H. Sinnott

In recent years the major task of the division has been the development of the Jindalee over-the-horizon radar working in the HF band. A pilot radar equipment (the Stage A radar) demonstrated successfully the potential usefulness of such technology in the defence of Australia, in particular for the long-range detection of approaching aircraft. Currently an advanced Stage B equipment is being installed at separate transmitter and receiver sites near Alice Springs. This equipment, using electronically scanned aerial beams, will demonstrate much increased coverage, improved sensitivity and automatic detection and tracking. The very large aperture electronically steerable receiving aerial and the high speed signal processor and waveform generators used in the Stage B radar have been developed in the division. All groups have contributed extensively to this radar development.

Other fields in which the division is working include microwave radar development and modelling (specifically, development of a moving target indicator system for a naval search radar), on-line measurement of search radar performance, and consulting services in radar for the new tactical fighter. Computer-aiding of tactical command and control is being studied and a TV scoring system for bombing exercises is being developed. Radio group is developing a land navigation system using existing VLF signals available from Omega and other transmissions, and specialised aerials for Service aircraft and is providing an electronic standards and measurement service.

Electronic Warfare Division, led by Mr J.S. Allison, assisted by Mr E.G. Hayman, contains groups on

- tropospheric studies — Mr K.B. Whiting
- ionospheric studies — Mr P.L. George
- infrared and optical countermeasures — Dr P. Crosby
- electronic warfare studies — Dr C.I. Chessell
- electronic warfare techniques — Mr J.F. Curtin
- systems studies — Mr G.E. Beltrame
- hybrid computing — Mr L.R. Henschke

The work of the division includes studies of countermeasure techniques in the radio, radar, optical and infrared fields, R&D on radio wave propagation via the ionosphere and in the troposphere, and the application of electronic warfare R&D methodology to acoustic warfare. Recent activities have included the simulation of weapons, of microwave electronic warfare and of a battlefield electronic warfare situation. The battlefield simulation uses a mock-up of an operations centre in which operators monitor the outputs of computer devices that analyse received signals, and can call for the employment of offensive measures (such as jamming) in attempts to disrupt the communications of an enemy. The simulator can be used to study questions of how best to use electronic warfare resources.

Optoelectronics Division is led by Mr J.R. Pyle. The groups in the division are

- night vision — Dr D.J. Gambling
- electro-optics — Mr L.J. Dunne
- optical techniques — Mr F.A. Dixon
- surveillance systems — Dr D.G. Cartwright
- computing services — Mr P.N.L. Goddard
- navigation — Dr K.J.W. Lynn

An experimental version of a laser airborne depth sounder (Lads) has been developed for Navy and successfully tested in a RAAF aircraft. Design studies for production in industry of engineered versions have started. There is

15. *ERL has investigated the accuracy of performance of Omega navigational equipment (frequency range 10-14 kHz) in RAAF aircraft. The use of Omega in land navigation is here being checked in the field. Phase transmission variations are being correlated over large areas of Australia so that real-time corrections can be applied to diurnal phase shifts and perturbations caused by solar activity.*

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work on more powerful blue-green lasers for other underwater applications and on the growth of single crystals with electro-optical properties for use as laser components. Development of optical thin films for use as filters and anti-reflection coatings has been extended to infrared wavelengths and the factors that affect adhesion under high-flux irradiations and in harsh environments are studied. Infrared technology appropriate to military surveillance and the propagation of IR through the atmosphere is studied. New types of IR and thermal imagers for use by Army and Navy are being developed. The work on uncooled IR detectors aims at developing cheap lightweight devices for widespread use in the Defence Force. Evaluation of the performance of IR detection systems in use by the Services is also carried out.

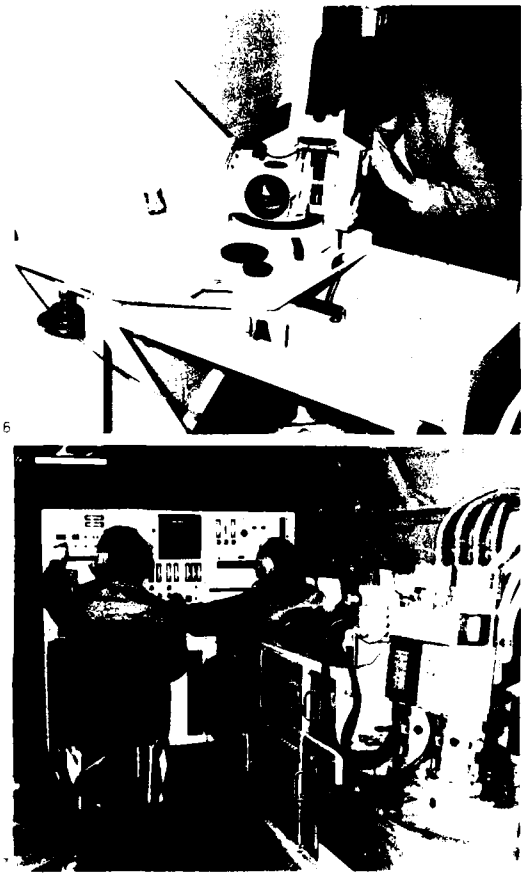
VLF propagation and Omega performance are studied. The effect of the Australian station as it becomes operational is being studied also.

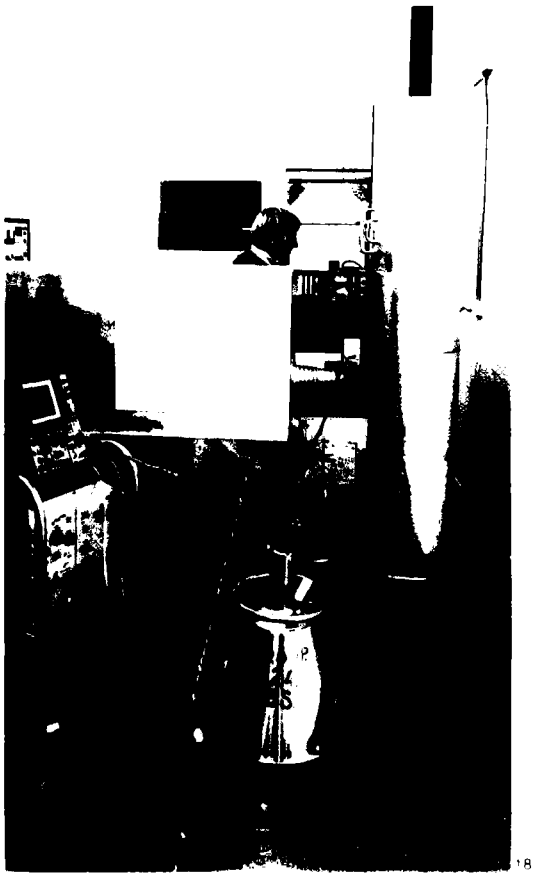
A centralised computer (currently an IBM 370/3033) has 150 remote terminals providing a time-shared computing service to users throughout the Defence Research Centre Salisbury area.

16. *The development of realistic simulators in a complex environment of electronic warfare is very important both for training and evaluation of equipment. This simulator was designed by ERL to measure the performance of an anti-tank guided-weapons system and built by Advanced Engineering Laboratory.*

17. *The laser airborne depth sounder, will enable more accurate mapping of the shallow waters around Australia's coast. It will do in 1 year what present resources would take 50 years to complete using conventional hydrographic methods. ERL personnel are shown operating an experimental system installed in a RAAF C47 aircraft.*

18. *Water vapour in the atmosphere alters the effectiveness of radars and communications equipment. This carbon dioxide light detection and ranging (Lidar) system was developed at ERL for measuring atmospheric water vapour profiles.*





Materials Research Laboratories

Director: Dr L.E. Samuels
Maribyrnong, Victoria; telephone (03) 31 7222;
PO Box 50, Ascot Vale, VIC 3032

The work of Materials Research Laboratories (MRL) ranges more widely than its name might suggest, including for example optical camouflage, high-energy lasers and some aspects of physiology and pharmacology. The professional staff number 200 and the annual operating budget is $15.5M.

Metallurgy Division is led by Dr M.E. de Morton with the support of Dr C.W. Weaver. Other senior officers are

- ammunition metallurgy – Mr I.R. Lamborn
- electrochemistry – Dr J.J. Batten
- high-temperature properties – Dr N.A. Burley
- machining and shaping – Dr G.R. Wilms
- welding and casting metallurgy – Dr J.C. Ritter
- metals characterisation – Mr I.G. McDonald

A significant accomplishment has been the development of two new nickel-based thermocouple alloys (Nicrosil and Nisil) by Dr Burley and his group. The new alloys give a cheap thermocouple with a performance similar to that of a noble-metal couple at temperatures up to 1200 C, and are coming into widespread use around the world. Another important area of work is electroslag refining of steel, and MRL is co-operating with Commonwealth Steel Pty Ltd in bringing this technique into use in Australia. Much of the work of the division is consulting work for the Defence Force and defence industry. There is research work on fracture mechanics (particularly as it applies to ordnance and fighting vehicles), the mechanics of penetration of armour, materials for fragmenting warheads, welding of ship steels, the corrosion of military equipment, the surface finish produced by grinding and machining, and quality control in electroplating operations.

Physics Division is led by Mr L.E.S. Mathias with the support of Mr D.R. Skinner. The groups are

- laser research – Dr A.D. McLachlan
- optics research – Dr L.O. Freeman
- radiation physics – Dr D.W. Williams
- electronics – Mr W.E.K. Gibbs

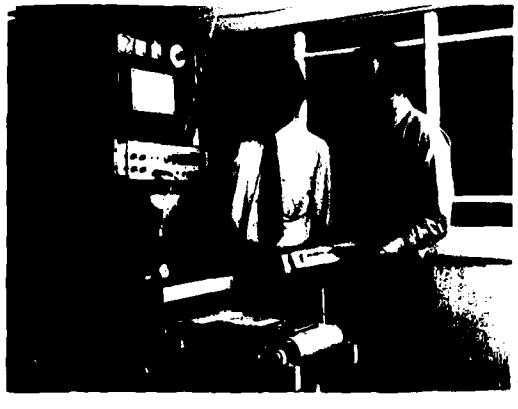
A major activity is the study of high energy lasers and their potential applications to defence. This work includes the investigation of new types of laser, the interaction of laser radiation with materials of defence significance, and the analysis of possible future applications. A recent success has been the computer-aided design of a disruptive camouflage pattern for the new Army combat uniform. This design was the product of continuing work on the psycho-physical aspects of target detection and on the measurement of colour in the field. Research carried out by radiation physics group is concerned with the protection of personnel and equipment from nuclear and electromagnetic hazards. An important aspect of this work is the prediction of radiation dosage under field conditions. Methods for the detection of hidden explosive devices are being investigated. Research conducted by electronics group covers topics such as control systems, computer simulation and applications of microprocessors.

Physical Chemistry Division, led by Mr W. Connick with the support of Dr J. Eadie, concentrates on

- ballistics research – Dr G.J. Jenks
- explosives research – Dr B.W. Thorpe
- explosives development – Mr J.R. Bentley
- explosives instrumentation – Mr J.S. Howe
- explosives testing – Mr D.J. Pinson
- explosives devices – Mr P. Ramsay
- explosives materiel – Mr R. Bird
- warheads research – Mr F.G.J. May
- electroballistics research – Dr A.J. Bedford

The division carries out R&D in explosives and ordnance, electromagnetic propulsion and terminal ballistics, and marine science. The work includes basic and applied research into the composition, initiation and detonation of explosives, the design and development of explosives-filled stores, the conduct of performance, serviceability and storage evaluations and the design, development and adaption of the specialised instrumentation needed for analysing explosive phenomena.

19. *Providing protection for the community against letterbomb attacks is of concern in a turbulent world. MRL have designed a system which uses a microprocessor to automatically screen mail at high speeds. Suspect articles can then be diverted for special handling procedures.*



The leader of **Organic Chemistry Division** is Dr P. Dunn, supported by Dr D.M. Pinkerton (organic materials and textiles technology) and Dr S.E. Freeman (physiology).

The groups are

- elastomers and plastics — Dr D.B. Paul
- structural adhesive research — Dr C.E.M. Morris
- liquid fuels research — Dr R.K. Solly
- paints — Mr F. Marson
- physiology — Dr S.E. Freeman
- personnel protection — Dr H.D. Crone

Areas of research in organic materials include environmental deterioration and stabilisation of polymers, polymer characterisation and modification, flammability, paints, the effects of laser radiation on organic materials, and adhesive bonding. There have been studies on the mechanical and chemical properties of plastics and glass-fibre-reinforced composite materials, the development of elastomers for military use (particularly underwater), the chemistry, application and performance of sealants, mainly polysulphides, and the synthesis and use of special organometallic compounds. In textiles technology there have been experimental studies on the degradation of military

20. *MRL scientists using the floating dock at Williamstown Victoria to assess the performance of galvanic anodes for cathodic protection of naval ships against corrosion.*

21. *MRL scientist laying up glass-fibre panels for exploratory work on the RAN Minehunter project. The red material is a pvc foam core to be used in the sandwich design of the hull.*

22. *Test firing of experimental smoke cartridges developed at MRL as part of a project aimed at producing an improved screening smoke for use by the Australian Defence Force.*

textiles, mycology, new textiles and investigations into methods of examining and assessing textiles. Because of the critical importance of liquid fuels to the Defence Force, research and investigational work is undertaken on a wide range of fuels, lubricants and related products. Studies are under way on the chemical characterisation of fuels derived from non-conventional sources, eg the pyrolysis of shale. There is research associated with the long-term storage of fuels and lubricants.

In order to be able to advise the Defence Force on specific aspects of chemical defence, research is in progress in areas of physiology, pharmacology and biochemistry. Background knowledge in toxicology is maintained and some experimental work undertaken on the pharmacology and biochemistry of toxins. Work is also carried out in the area of therapy for chemical agent intoxication and on the assessment of traumatic injury. Studies on respirators and filters, protective items and special clothing are undertaken. Other research areas include the detection and estimation of toxic gases, dusts and smokes, and decontamination. Problems associated with heat stress due to the wearing of protective equipment under Australian environmental conditions are investigated.

23. *Equipment designed for the northern hemisphere can be unsuitable or deteriorate rapidly in the Australian environment. MRL has found camouflage solutions for our very diverse terrains, and materials and dyes which can withstand intense uv radiation for uniforms and camouflage nets. Shown is a field trial of a prototype telespectrophotometer — a novel instrument for measuring the spectral reflectance in the range of 350-1500 nanometres, of terrain objects.*

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Weapons Systems Research Laboratory

Director: Mr J.W. Crompton
GPO Box 2151, Adelaide, SA 5001;
telephone (08) 259 9111
Location: Defence Research Centre Salisbury, SA

Weapons Systems Research Laboratory (WSRL) is charged to develop expertise in

- aeroballistic aspects of weapons and weapon systems
- rocket and gun propulsion systems including propellants
- combat data and display systems
- guidance and control systems for weapons and remotely piloted aircraft
- underwater detection systems
- the integration of systems

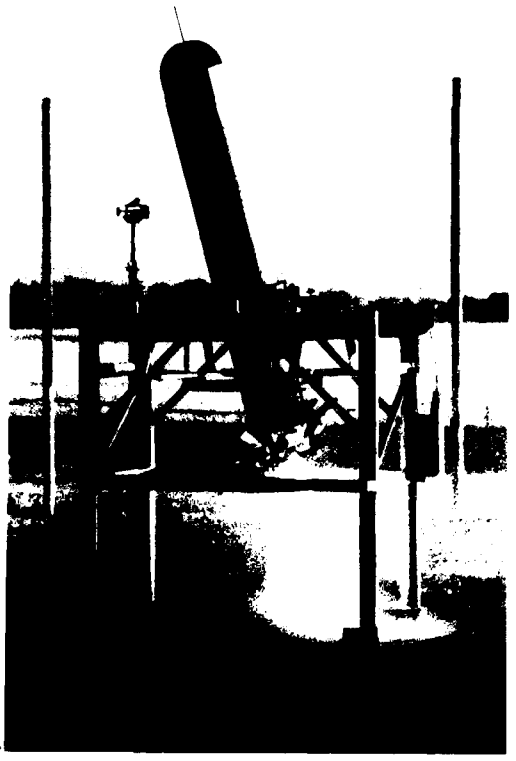
and to apply this expertise to the solution of current Australian military problems, and to conduct R&D on matters in these and related fields that are judged to be likely to have defence applications in the future. The staff of 420 includes some 140 professional scientists and engineers. The annual operating budget is about $12M.

Aeroballistics Division, led by Mr P.M. Twiss, carries out research on weapon flight dynamics using mathematical models and flight trials; aerodynamics research, using wind tunnel and free flight techniques; studies of ballistic weapons systems and research in exterior ballistics. The ballistics work is led by Mr J.H.W. Shannon, whose groups are

- ballistics studies — Mr I.C. Heron
- flight research — Mr P.H.O. Pearson
- field experiments — Mr R.E. Kane

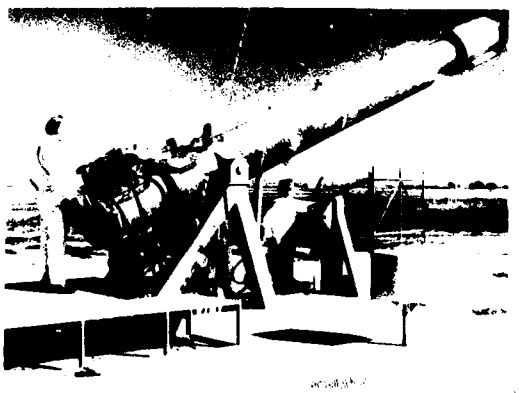
There is a group working on nonlinear dynamics and computational fluid dynamics under the leadership of Mr L.M. Sheppard. Aerodynamics research group, concerned with theoretical aerodynamics and supersonic wind tunnel experiments, is headed by Mr K.D. Thomson.

Weapons Systems Division is led by Mr P.O. Gillard. It is concerned with integrating sub-systems to form larger systems (for example, integrating a new system into an existing aircraft avionic system), mathematical modelling of systems and evaluation of missile performance, command data systems, the development of systems, the technology of remotely piloted aircraft and their imaging systems, terminal guidance of missiles and munitions through the use of lasers, and the passive acoustic underwater detection of submarines. The groups concerned



24. *Australia's development centre for the design and testing of rocket motors is in WSRL. A rocket motor is shown during a thrust vector control test.*

25. *WSRL has designed and built gas-operated guns for investigating the aerodynamic behaviour of various types of missiles. This 38.4mm gas gun projects small missiles at speeds of 50 to 230m/s. Other authorities have used it for testing structures required to withstand the impact of cyclone-borne debris.*



with weapon guidance, remotely piloted aircraft and weapons systems are

- systems integration — Dr J.M. Wilson
- systems modelling — Mr M.L. Possingham
- command data systems — Mr K.W.J. Todd
- systems development — Mr W. Craick
- remotely piloted vehicles techniques — Mr R.J. Rockliff
- terminal guidance — Mr C.H. Low

The underwater acoustic work is led by Dr L.B. Travers. His groups are

- underwater detection — Mr D.H. Brown
- signal processing and classification — Mr G.C. Mountford
- sea experiments — Mr K.G. Wood

Propulsion Division, under Dr W.G.P. Robertson, is responsible for R&D in gun and rocket propellants, rocket propulsion, interior ballistics and the propulsive aspects of guns and ammunition. The work of Propulsion Division includes R&D on polymer-bonded explosives and materials used in propulsion systems. Propulsion Division is Australia's development centre for the design and testing of rocket motors, and also provides R&D support to munitions production. The groups are

- nitrocellulose propellants — Dr B.H. James
- composite propellants and explosives — Mr J. Hooper
- gun propulsion research — Dr I.M. Napier
- rocket propulsion research — Mr W.A. Bradfield
- propulsion systems — Mr A.L. Odgers

Recent work in WSRL has included

- research on the development of the Barra sonobuoy in conjunction with the Advanced Engineering Laboratory.
- the development of an intelligent console for the control of a drone aircraft
- work on a field artillery fire control system
- the invention of a device for determining meteorological data for artillery purposes
- effects of electronic warfare on artillery operations
- a determination of the minimum safe towing distance for a target behind an aircraft for air-to-air gunnery practice
- an investigation into the feasibility of refurbishing the RAN's 'Standard' anti-aircraft missiles in Australia
- the chemistry of propellant deterioration and improved prediction of service life
- an electronic 'thermal integrator' for co-storage with rocket motors and other explosives-filled stores to

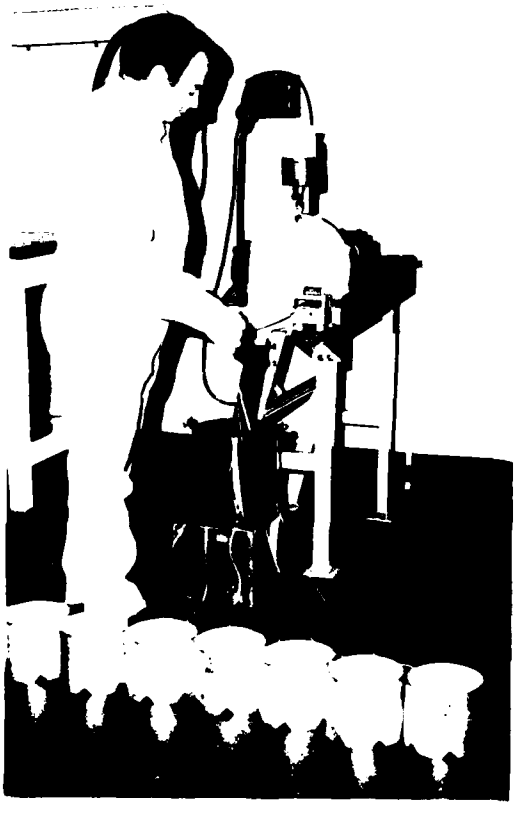
26. *WSRL contributes to the development of laser systems technology in Australia. This experimental laser target-designator was developed by WSRL, with support from Advanced Engineering Laboratory and Electronics Research Laboratory, for recent RAAF laser-guided bomb trials.*

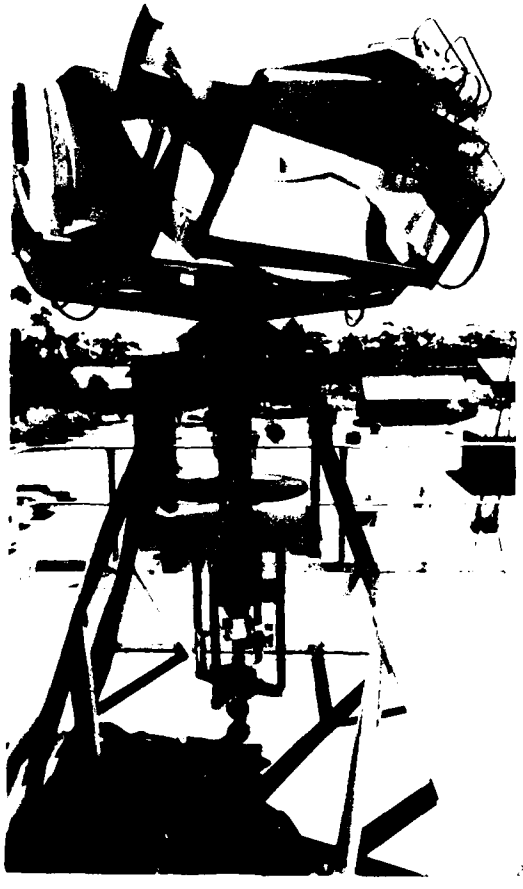
monitor the progress of time/temperature deterioration towards service life expiry

- a laser target-designator to form part of a terminal-guidance unit for an artillery shell
- research on terminal-guidance aerodynamic control canards for artillery shells
- causes of inaccuracy with shoulder fired weapons and development of training aids
- controllable modulation of thrust magnitude and direction of solid propellant rocket motors
- advances in control and platonisation of rocket propellant burning rates
- high strain-rate mechanical properties of gun propellants
- improved computer programs for interior ballistics modelling
- application of microprocessors to the control of propellant processing
- feasibility studies and exploratory development of rocket propulsion systems
- 'Australianisation' of propellants (small arms, artillery and rocket) for foreign munitions under consideration for local production
- continuing background research in a number of areas including
  - subsonic aerodynamic cross-flows on a cylindrical body
  - advanced sonobuoys
  - propellant ignition and combustion, and combustion instability
  - an instability of spinning shells produced by control forces.

27. *WSRL conducts gun as well as rocket, propulsion research. R&D is also provided to munitions production. Here propellant cord is being cut into powder granules.*

28. *A track-while-scan radar designed and developed by WSRL.*





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Armed Forces Food Science Establishment

Director: Dr R.J. Richards
Scottsdale, Tasmania; telephone (003) 52 2033
PO Box 147, Scottsdale, TAS 7254

Armed Forces Food Science Establishment (AFFSE) has a staff of 27 and an annual operating budget of $0.8M. Its basic charter is to determine the energy and nutrient requirements of servicemen under all conditions in which they may be expected to operate and to translate these needs into ration scales for static mess feeding and ration packs for combat purposes.

The **Food Technology and Experimental Processing** section, headed by Dr R. Beyer, develops new food forms with defence significance and monitors commercial innovations. It operates many types of food dehydration equipment and has developed freeze-drying as a major method of food processing. It conducts research into food packaging and factors affecting food texture and acceptability.

1/2. *AFFSE determines food requirements for military conditions and researches processing, storage and packaging able to withstand long periods of extreme heat and rough handling. The establishment has patented water sterilising tablets now on the world market, and developed for RAAF/Army emergency water packs that are resealable and can withstand pilot ejection forces as well as low pressures of unpressurised aircraft. These pictures show packing of emergency flying rations for RAAF (below) and measurements being taken of a serviceman's energy expenditure (right).*

Mr K. James leads the **Food Science** section in chemical and microbiological analyses of food, and develops new methodology in these disciplines. The section determines the safety parameters for special food types and provides specifications for organisations setting legal standards.

The **Nutrition/Physiology** section under Dr G. Driver conducts food acceptability studies for servicemen in various situations, develops special ration packs for combat and survival situations and determines the energy needs of servicemen, including highly specialised groups.

The Establishment has wide contacts with other food scientists and commercial manufacturers. It reviews its programs regularly with other organisations working in related fields. Its membership of the Commonwealth Defence Science Organisation through the Food Study Group enables it to maintain international contacts in food science.

Central Studies Establishment

Superintendent, Analytical Studies: Mr A.R. Taylor
Campbell Park Offices, Department of Defence,
Canberra, ACT 2600; telephone (062) 66 4309

Central Studies Establishment (CSE) carries out analytical studies on force structure, defence planning, equipment proposals, weapons systems, logistics and manpower. Studies in these areas are also done by the small operational research groups attached to the Scientific Advisers to Navy, Army and Air; these groups usually deal with short, single-Service studies, while CSE handles larger studies or those extending beyond a single Service. CSE has a staff of 50 and an annual operating budget of $1M.

Combat Studies Group, under Mr I.R. Ridgway, analyses the effectiveness of military systems and operations. A typical study concerned the best tactical means (tactical doctrine plus appropriate combinations of ships, missiles, electronic warfare equipment, etc) for protecting surface ships against attacks by aircraft, submarines or ships during the 1990s.

The work of **Strategic Studies Group,** led by Dr M.W. Jarvis, is directed at assisting the taking of annual decisions about the equipment to be included in the Defence acquisition program for the ensuing five years (known as the Five Year Rolling Program). This is done by developing alternative force mixes that are adequate for their assigned tasks in postulated operations and relating these mixes to defence policy objectives.

Management Studies Group, led by Dr R.G. Body, has in recent times investigated fire prevention in Defence facilities, economical means of providing housing for servicemen, and aspects of modernising Garden Island Dockyard, Sydney.

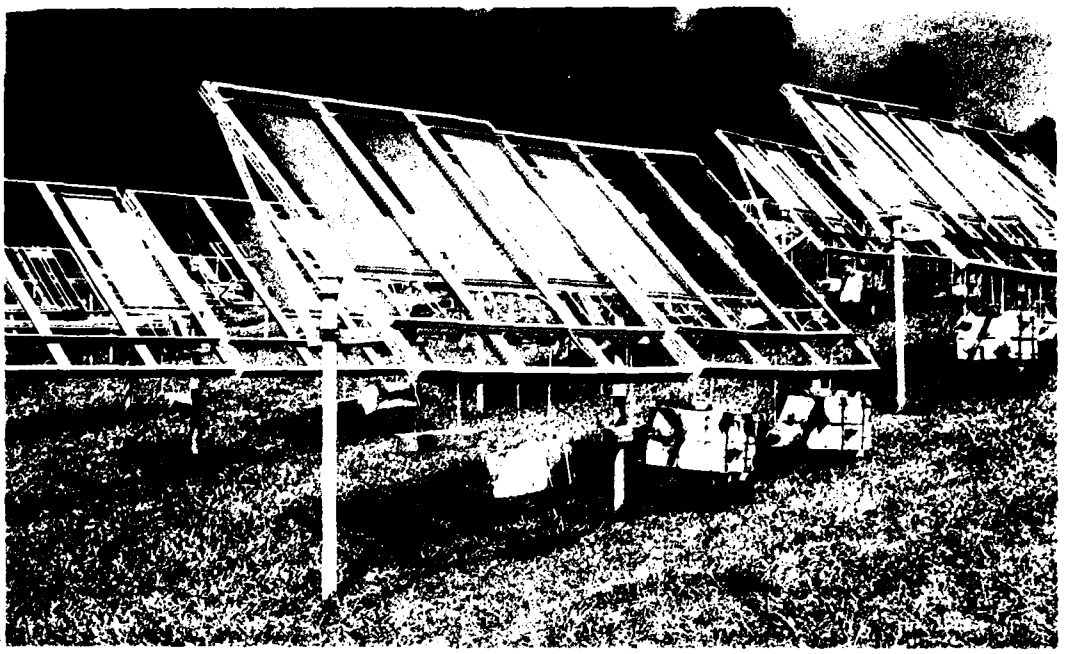
Costing, Manpower and Support Group, under Mr D.A. McCallum, provides assistance to the other groups. Methods have been developed for assessing the life-cycle costs of major defence equipments. The work of the group has also included the RAN Officer Structure Study, in which a model was developed of the long-term effects of various personnel policies on naval officer manpower and career prospects.

3/4. *CSE's complex analytic studies cover many fields from, for example, an analysis of warning times for conflicts, to solutions to combat, strategic or management problems, as well as logistics, manpower, life cycle costs and attrition rates of military equipment. CSE made major inputs to the extensive new tactical fighter studies prior to the decision to acquire the F/A-18 aircraft.*

Joint Tropical Trials and Research Establishment

Officer in Charge: Mr N.S. Dempster
Pin Gin Hill, Palmerston Highway near Innisfail
Queensland; telephone (070) 61 3477
PO Box 838, Innisfail, QLD 4860

Joint Tropical Trials and Research Establishment (JTTRE) has a staff of 26 and an annual operating budget of $0.8M. It carries out investigations and research on the effects of tropical environments on materials, equipment and electromagnetic wave propagation; and on mechanisms of degradation, ways of measuring degradation and the classification of tropical environments. It carries out a



5/6. *JTTRE maintains trials and research sites in the hot wet rainforests and hot dry interior of north Queensland. Long term site histories have been compiled since 1962 and both static and dynamic exposure trials of various materials have been conducted such as these (top) on exposure racks at Pin Gin Hill. The most exacting of tropical trials like this recovery trial (right) are mounted at JTTRE for the Services and our UK and US partners.*

program of tropical testing sponsored jointly by Australia and UK, work for the Australian Services, collaborative work with other DSTO laboratories on radio communication and infrared propagation, and work with Australian Telecommunications Commission on radio propagation from satellites. Facilities have been established at Cowley Beach and Tully for mobility trials of vehicles, for the firing of weapons at Cowley Beach or in the jungle, and for testing rockets, bombs and ammunition. By arrangement, tests are carried out for manufacturers and others concerned with the behaviour of materials or equipment in the tropics.

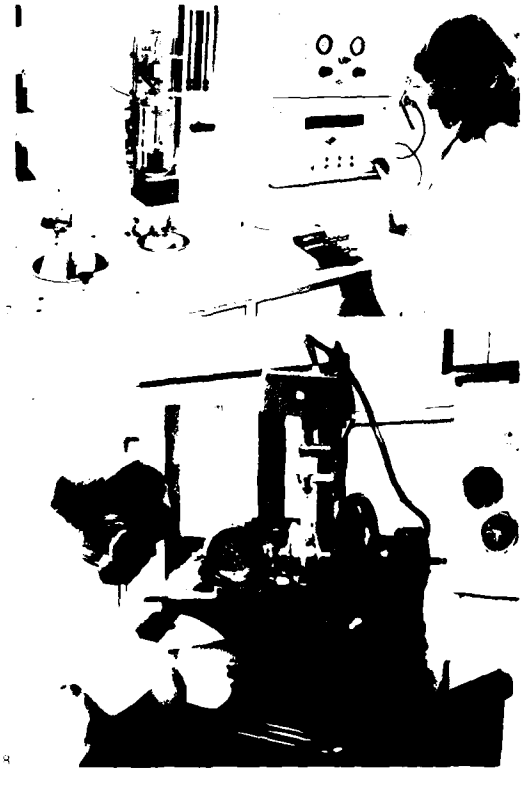
Sites at Pin Gin Hill, Cowley Beach and Cloncurry provide hot-wet, hot-wet-jungle, hot-wet-marine-atmospheric and hot-dry conditions, and in addition specimens may be immersed in warm sea water in Mourilyan Harbour and at the North Barnard Islands. Materiel such as trucks, bombs, howitzers, a bridge, ration packs and clothing have been exposed. Materials such as plastics, rubbers, composites, adhesives, antifungal paints, antifouling compositions (for ship's hulls), textiles, light alloys and building materials have been, and are being, exposed for periods of from 6 months to 20 years. Some specimens are exposed under statically or dynamically stressed conditions. It has been found that exposing rubbers or plastics in the form of thin films provides a means for achieving a more rapid evaluation of degradation. The hot-wet conditions at Pin Gin Hill and Cowley Beach provide a useful accelerating factor in experiments designed, for example, to measure the stress below which a crack in a weld in an aluminium structure remains stable.

Materials Testing Laboratory

Officer in Charge: Mr K.C. Pirani
51 Bourke Road, Alexandria, NSW;
telephone (02) 667 2427
PO Box 60, Alexandria, NSW 2015

Materials Testing Laboratory (MTL) has a staff of 40 and an annual operating budget of $1M. It provides a consultant and investigatory service in areas of non-destructive inspection, physical metallurgy, corrosion and mechanical testing. There are facilities for the examination and analysis of textiles, petroleum products, paints, non-organic finishes, and explosives.

7/8. *MTL provides consultant and investigatory services for the Australian Defence Force and defence industry. Counting of particulate contamination in oils is shown (7), and below X-ray diffraction analysis is being conducted using a new type of camera developed at MTL and patented by the Australian Government.*

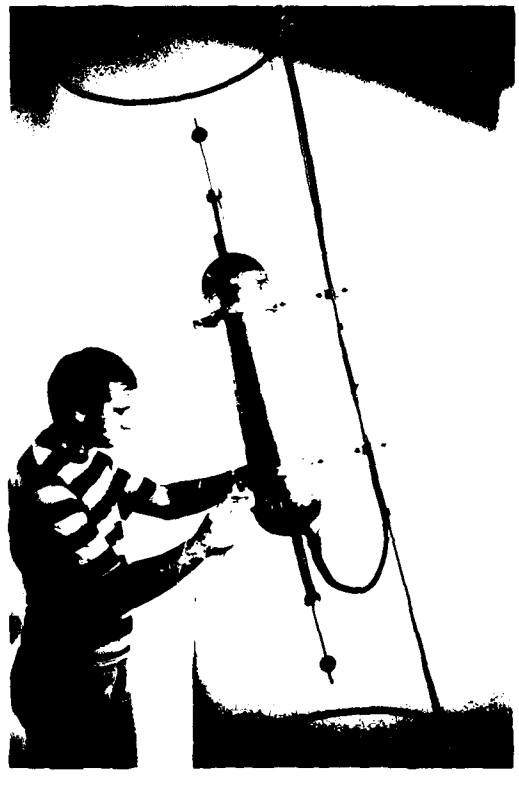


Royal Australian Navy Research Laboratory

Director: Dr W.F. Hunter
New Beach Road, Edgecliff, NSW;
telephone (02) 32 2211;
PO Box 706, Darlinghurst, NSW 2010

Royal Australian Navy Research Laboratory (RANRL) carries out operations research studies of maritime warfare and research on underwater acoustics, oceanography, sonar and mine warfare; works at automating the processes of gathering data during the conduct of maritime

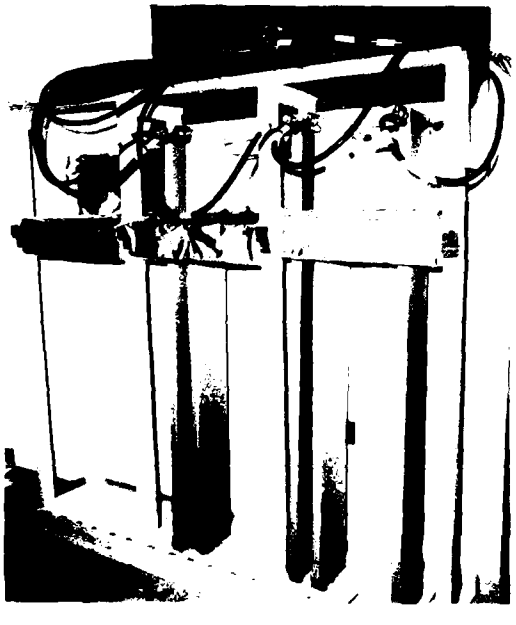
9/10. *Most of the work done by RANRL is on Navy equipment and research into Australia's oceanographic environment and its defence implications. A Jasin-Gradient Richardson Number Probe (below) which has electromagnetic current meters and thermistors at each end, is here being checked. RANRL has worked with Advanced Engineering Laboratory to produce the successful Mulloka ship mounted sonar. These Mulloka staves (overleaf) shown in a transit case, have been tested in the laboratory and at sea.*



exercises and of analysing it; and carries out R&D on the improvement of weapons and equipment and on possible future equipment. Its work is predominantly for RAN, some has been for RAAF. There is a professional staff of some 35 scientists and engineers, and 50 other staff. The annual operating budget is $2.6M.

Over a period of years much work has been done on the eddies that form in the ocean off the eastern coast of Australia and on the Tasman oceanic front which extends between Australia and New Zealand. This work has been carried out by the ocean sciences and sonar groups of RANRL, with some support from Weapons Systems Research Laboratory Salisbury, and, in some parts of the work, in collaboration with scientists of CSIRO and overseas laboratories.

Operations Research Group is led by Mr M.D. Frost. Its work includes studies of submarine and anti-submarine warfare, air defence, maritime surveillance and patrol, surface and air strike operations, naval force composition and levels, and the automation of the processes of gathering and analysing data from maritime exercises. Recently, analysis effort has been applied to exercises in the Kangaroo (Coral and Tasman Seas) and Sandgroper (Indian Ocean) series.



Ocean Sciences Group, led by Dr I.S.F. Jones, concentrates on underwater acoustics and physical oceanography. Their work has included research on turbulent mixing in the upper ocean, the analysis and prediction of tides in Bass Strait, participation in the work on mesoscale ocean eddies, investigations into mixed layer temperature profiles, the relation between the propagation of sound in the water and microwave energy in the air above it, radar ducting over water, ambient sea noise and the theory of underwater surface-duct sound propagation.

Sonar and Surveillance Group is led by Mr J.C. Waller. It has made a substantial contribution to the development and testing of the Mulloka ship-mounted sonar, working with AEL. It has worked on signal processing, sonar arrays, submarine sound ranges, sonar displays matched to the human operator, and new sonar and weapon systems for submarines.

Mr W.J. Turner is in charge of **Mine Warfare Group,** which is concerned with studies of mine warfare, the analysis of mine-countermeasures exercises, the development of clearance diving equipment including training devices, defence against underwater saboteurs, mine-countermeasures equipment and computer-based mine-warfare planning techniques.

The **Engineering Group,** under Mr C.A. James, engineers and deploys devices to operate in the ocean and develops telemetry and data-logging systems.

THE DIRECTORATE OF TRIALS

The Directorate of Trials is part of DSTO central office in Canberra, and is responsible for the planning, co-ordination and management of Defence Trials for all three Services. The Director is Capt. N. Newman RAN, telephone (062) 66 4446.

Defence Trials, which are user oriented, may be conducted for many reasons – for example, to determine the extent to which materiel which has been developed or is being considered for acquisition, meets stated requirements; to examine the effectiveness of equipment modifications or the performance of existing items under new conditions; or to assess the overall impact of introducing into service new concepts or new equipment.

The Directorate usually has some fifty trials of various magnitudes being planned, conducted or reported on, and uses many trials agencies, including elements of the Services, DSTO establishments, and organisations such as CSIRO.

Information current at March 1983

Weapons Systems Research Laboratory

p21 Telephone No. has changed to 259 5555.

Mr J.W. Crompton has retired and the Director's position is currently occupied by Mr P.O. Gillard.

Aeroballistics Division: Mr E.H. Barnard-Brown is now leader of field experiments group; Mr G. Jepps now leads dynamics group; Mr M.L. Robinson is now the leader of aerodynamics research group and Mr K.D. Thomson now leads an aircraft stores interaction research group.

Weapons Systems Division: Dr L.B. Travers is currently head of the division.

p22 Mr W. Craik has retired and Mr R.J. Green is currently head of systems development group; Mr D.H. Brown is now head of the marine studies composite which does underwater acoustic work, and Dr A.L. Carpenter is now leader of underwater detection group.

Propulsion Division: Dr B.H. James (rocket propulsion research) and Mr L.M. Sheppard (gun propulsion research) assist Dr W.G.P. Robertson to lead the division. Mr J.F. Hooper is now leader of nitrocellulose propellants group; Dr C.W. Fong is now leader of the composite propellants and explosives group; Mr J.L. Atkinson is the current leader of propulsion systems group (formerly led by Mr A.L. Odgers).

Central Studies Establishment

p25 Dr R.G. Body is now the leader of Strategic Studies Group and Dr M.W. Jarvis is the leader of Management Studies Group.

Joint Tropical Trials and Research Establishment

Mr N.S. Dempster died in 1983 and Mr W.R. Hindson is currently occupying the position of Officer in Charge.

Materials Testing Laboratory

p27 Telephone No. has changed to 693 4222.

This laboratory was transferred out of DSTO on 1 July 1984 to the responsibility of Chief of Supply and Support.

Royal Australian Navy R[illegible]rch Laboratory

p27 Mr M.D. Frost is currently occupying the position of Director.

p28 Mr B.F. Wild is the current leader of Operations Research.

Department of Defence
DSTO INFORMATION BOOKLET

CORRIGENDA AT 1 JULY 1984

The following significant changes have occurred since the text went to the printer

Advanced Engineering Laboratory

p9 Telephone No. has changed to 259 5555

Mr J E H. Lamprey has retired and Mr R D. Ramsay is now Director

Communications and Electronic Engineering Division: Mr J.I. Renton currently leads the division; Mr J. McKibbin now leads the underwater systems engineering groups and Mr D.J. Whitford is the leader of underwater systems development group; Mr T. Puust is now the leader of sonar engineering group

Mechanical Engineering and Workshops Division: Mr N.C. Frost is now the leader of airborne structures and instrumentation group.

Aeronautical Research Laboratories

p13 Aerodynamics Division: Mr R.A. Feik is now the group leader for rotary wing aircraft behaviour studies; Mr T.H. Trimble has retired and Mr M.K. Glaister is now the group leader for wind tunnels operation.

p14 Mechanical Engineering Division has been redesignated Aeropropulsion Division and Mr F.H. Hooton has retired.

p15 Systems Division: Dr P.F. Preston currently heads the division; Dr C.R. Guy is the current leader of systems operation group

Electronic Research Laboratory

p16 Telephone No. has changed to 259 5555

Electronic Warfare Division: Mr D.F. Fyfe is now leader of ionospheric studies group.

Optoelectronics Division: Dr R.S. Seymour is now the leader of optoelectronics devices group; Mr H. Evans is now leader of computing services group

Materials Research Laboratories

p18 Telephone No. has changed to 319 4499.

Dr L.E. Samuels has retired and Mr W. Connick is now Director.

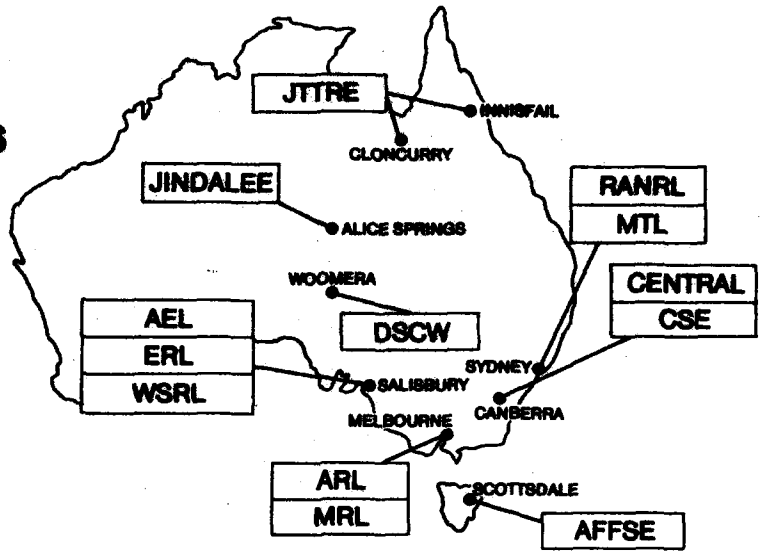
Metallurgy Division: Mr I.R. Lamborn has retired and Dr A.J. Bedford is now the group leader for ammunition metallurgy; Dr N.A. Burley has left and Dr G.R. Johnston is now group leader for high temperature properties, metals characterisation group has been disbanded

Physics Division: Mr W.E.K. Gibbs and Dr C.I. Sach assist Mr L.E.S. Mathias to lead the division; Dr C.I. Sach is now group leader for laser research; Dr L.O. Freeman has retired and Mr D.R. Skinner is now leader of optics research group

Physical Chemistry Division: Dr J. Eadie currently leads the division with the support of Dr B.W. Thorpe; Dr D. Whelan is now the contact for explosives research; electroballistics research group has been absorbed into Physics Division.

p19 Organic Chemistry Division: there is also a polymer research group led by Mr R.A. Cummins.

DSTO Principal Locations



LEGEND

AEL	Advanced Engineering Laboratory	JINDALEE	Over-the-horizon radar installation
AFFSE	Armed Forces Food Science Establishment	JTTRE	Joint Tropical Trials Research Establishment
ARL	Aeronautical Research Laboratories	MRL	Materials Research Laboratories
CSE	Central Studies Establishment	RANRL	Royal Australian Navy Research Laboratory
DSCW	Defence Support Centre Woomera	MTL	Materials Testing Laboratory
ERL	Electronics Research Laboratory	WSRL	Weapons Systems Research Laboratory

Functions and Roles of DSTO

As approved by the Minister for Defence February 1980

FUNCTIONS

The functions of the Defence Science and Technology Organisation are to:

a. provide scientific and technical advice on defence policy matters;

b. provide scientific and technical support:

(1) to the Australian Defence Force in its task of maintaining effective forces in being and for the development of the Force;

(2) for the acquisition of defence material; and

(3) for such other matters as specified by the Minister for Defence;

c. maintain a technology base to support the Australian Defence Force, the Department of Defence and defence industry; and

d. [illegible] the initial development of selected prototype equipment to meet [illegible] proved Defence requirements.

towards Defence needs, and contribute to scientific and technological knowledge;

b. maintain and extend knowledge of the physical environment in which Australian Defence Force personnel and equipment may operate;

c. conduct studies and operational analyses for the Australian Defence Force and other elements of the Department of Defence;

d. develop and modify, plan and conduct trials on, test, evaluate and provide through-life scientific and technological support for agreed Defence equipment;

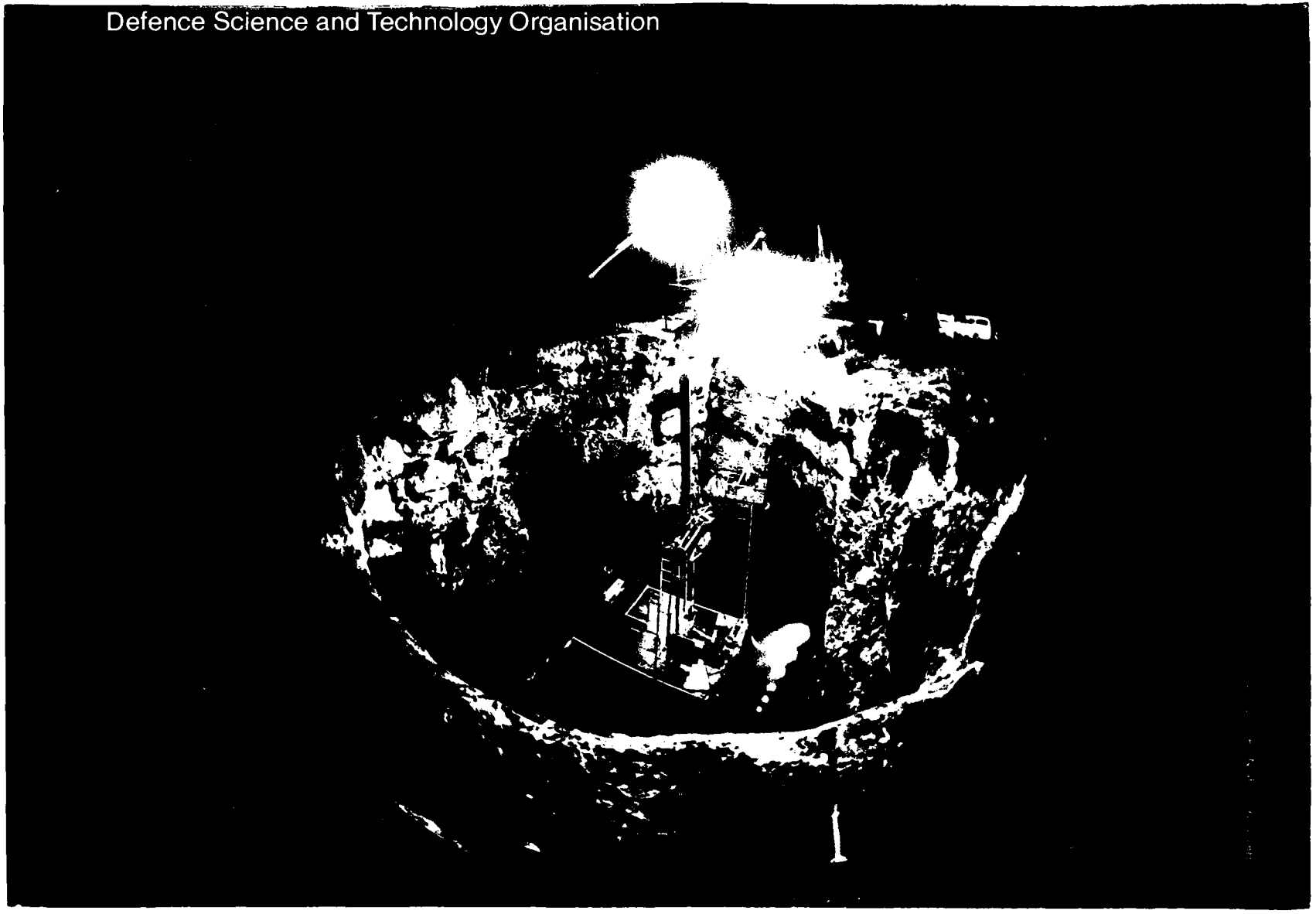
e. develop and manage Department of Defence participation in international agreements for scientific and technological exchange and collaboration;

f. co-ordinate industry participation in research and development of relevance to the Defence Science and Technology Organisation program;

g. provide an expert technical advice and support to assist industry in defence projects.

h. [illegible] departmentally agreed work for others where [illegible] Defence and Technology Organisation has special expertise or equipment and [illegible] interests [illegible]

Defence Science and Technology Organisation



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